CONCRETE
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CONSTRUCTIONAL ENGINEERING

INCLUDING PRESTRESSED CONCRETE

JUNE, 1952. Vol. XLVII, No. 6

FORTY-SEVENTH YEAR OF PUBLICATION

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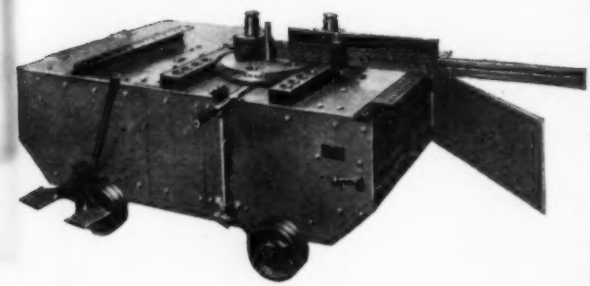

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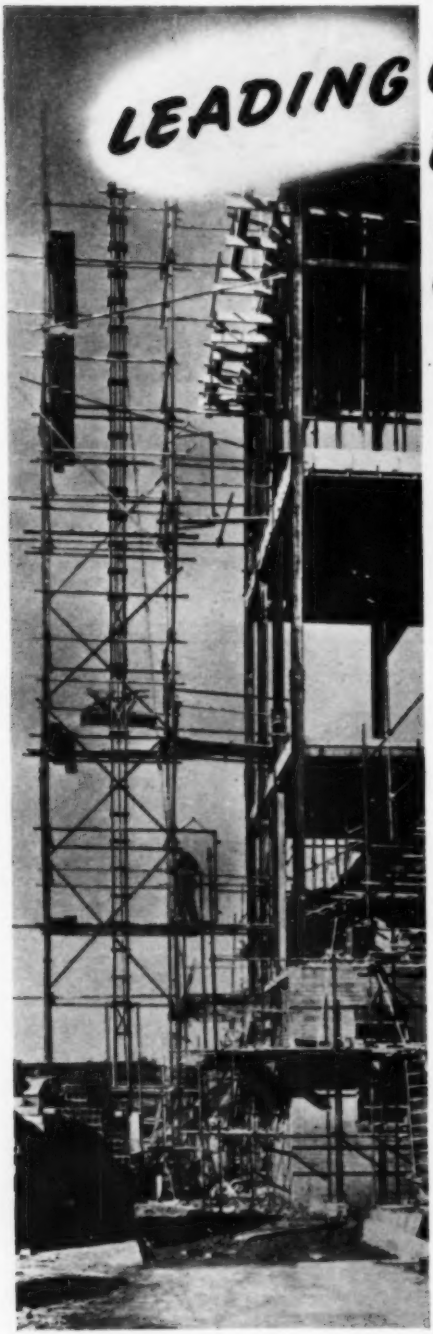

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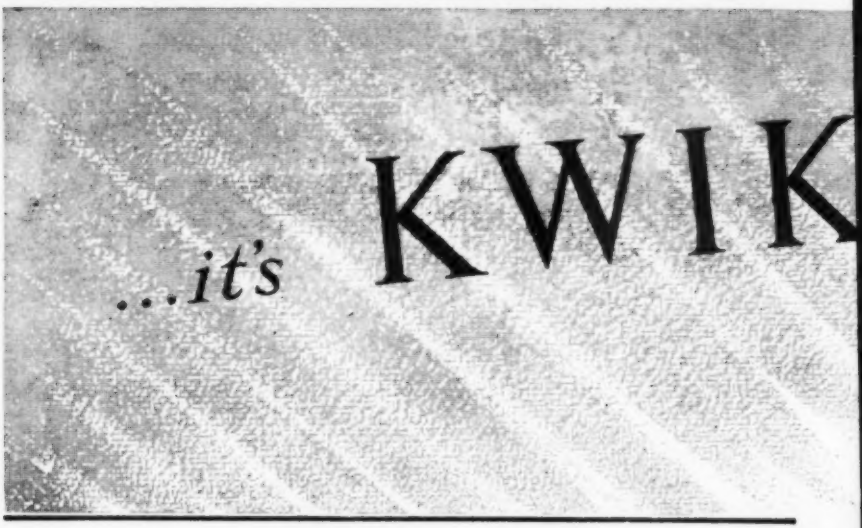

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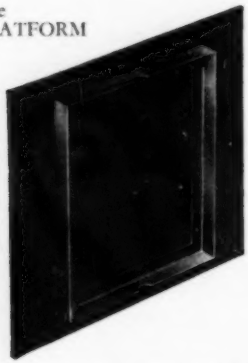

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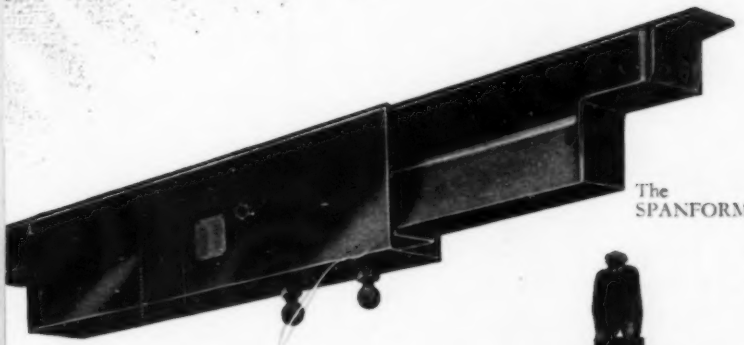

The SPANFORM

The above illustration shows Flatforms being laid in position.

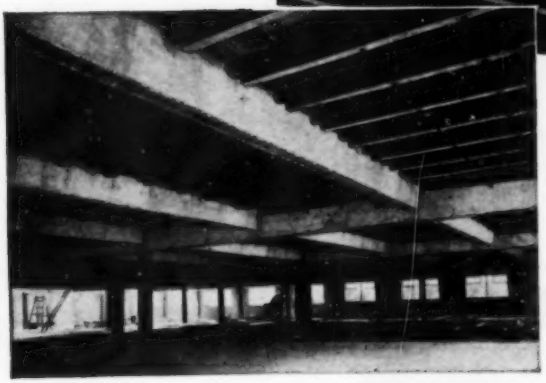

Illustration left shows Spanforms and decking supported on concrete haunching.

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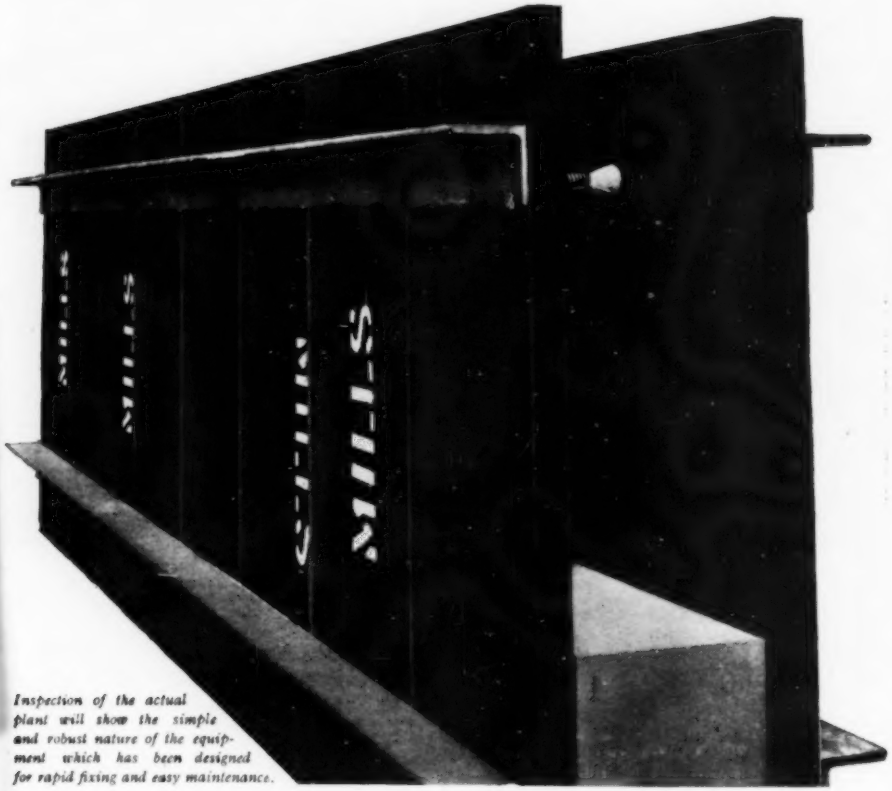

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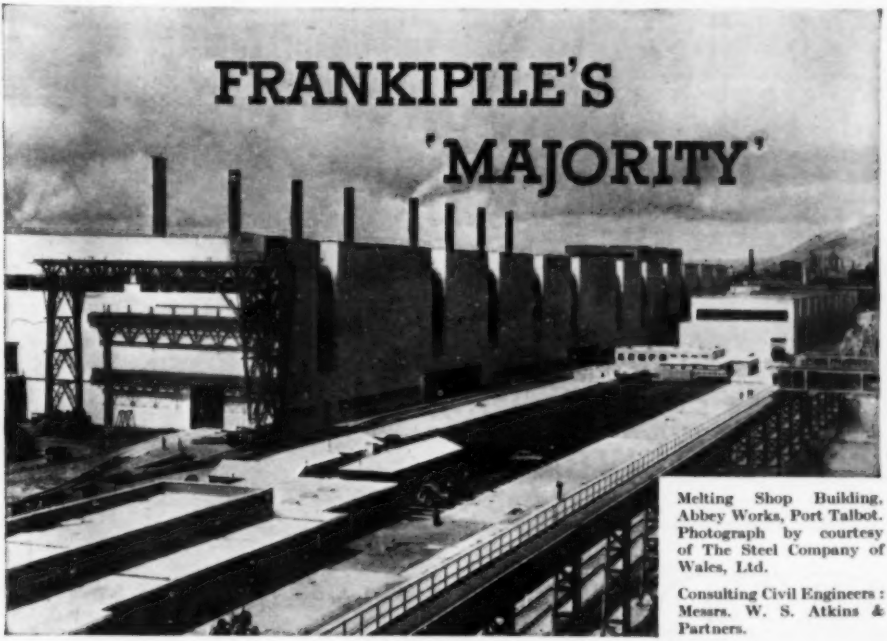

Melting Shop Building, Abbey Works, Port Talbot. Photograph by courtesy of The Steel Company of Wales, Ltd.

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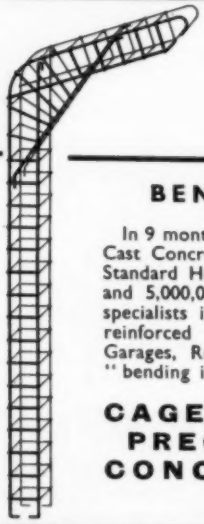

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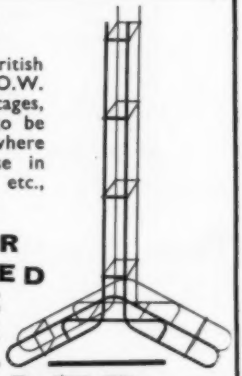

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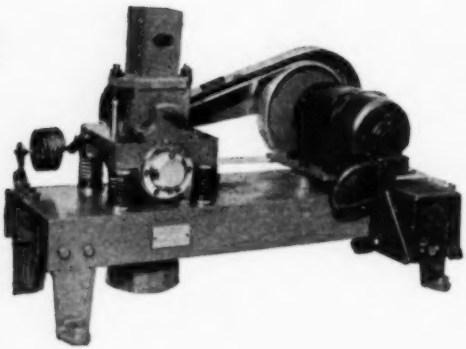

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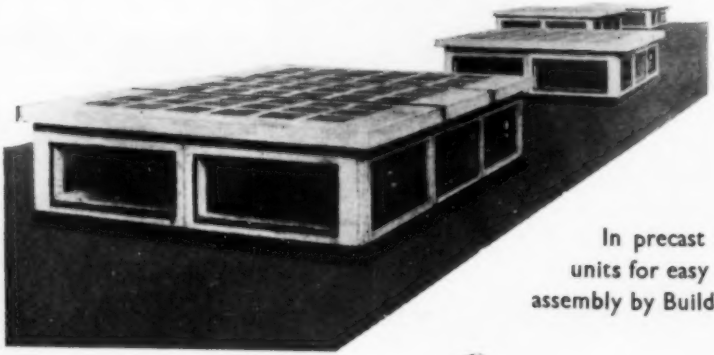

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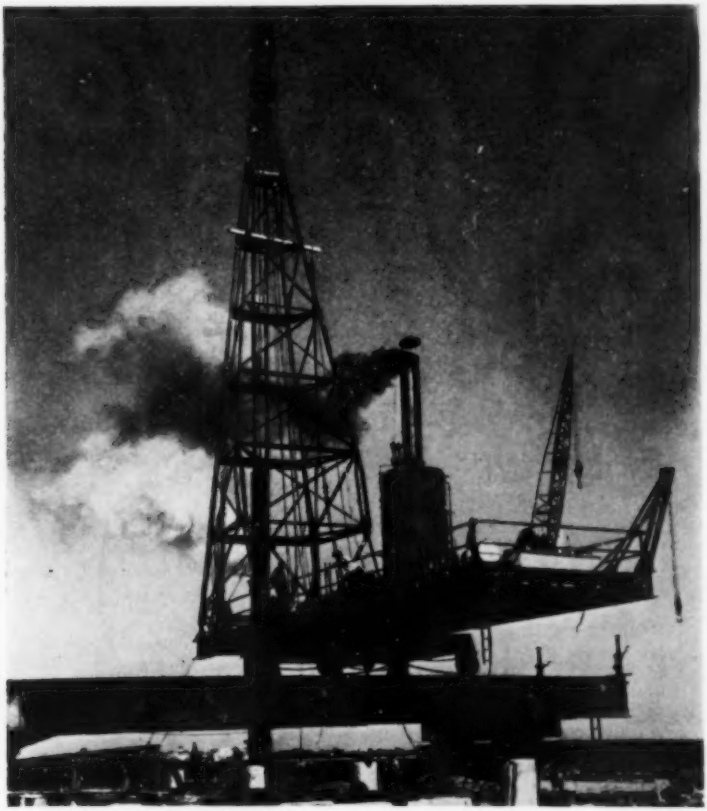

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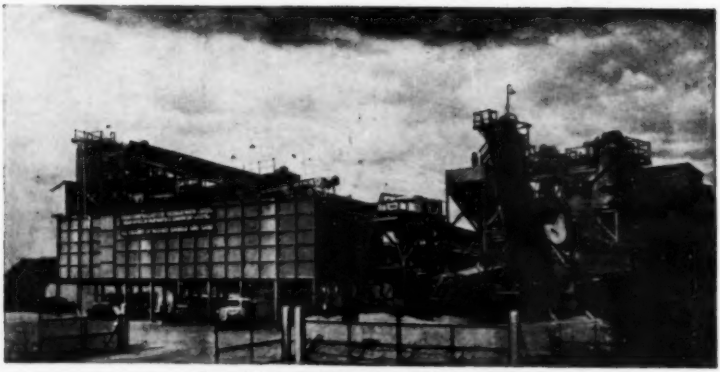

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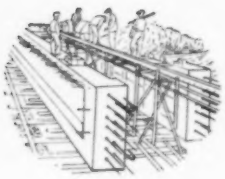

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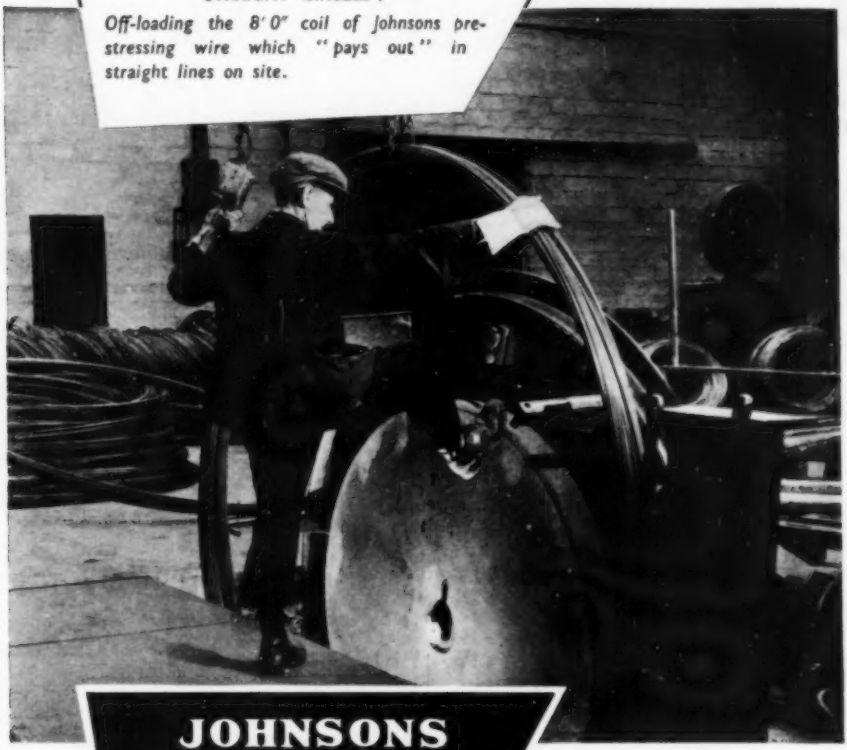

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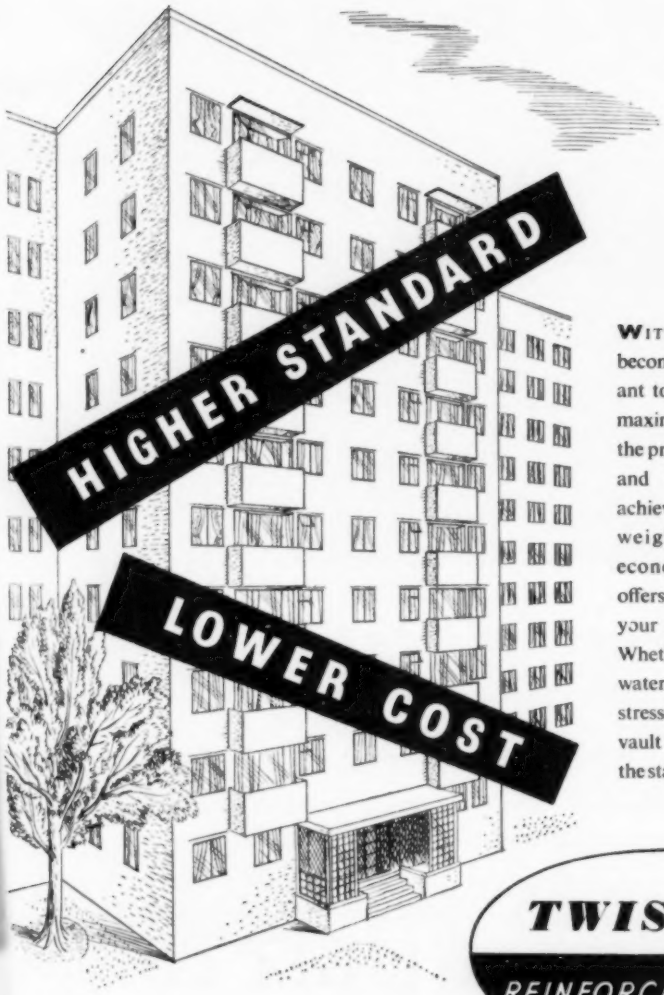

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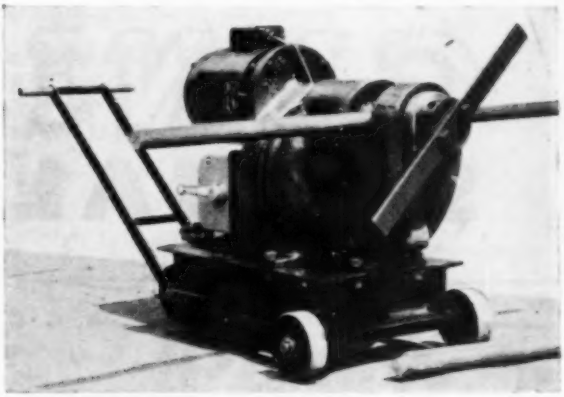

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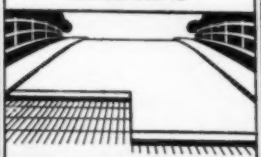

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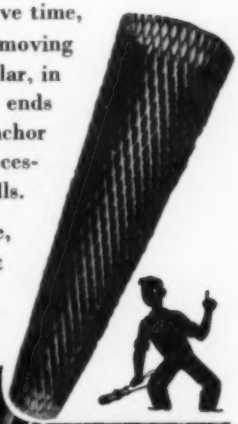

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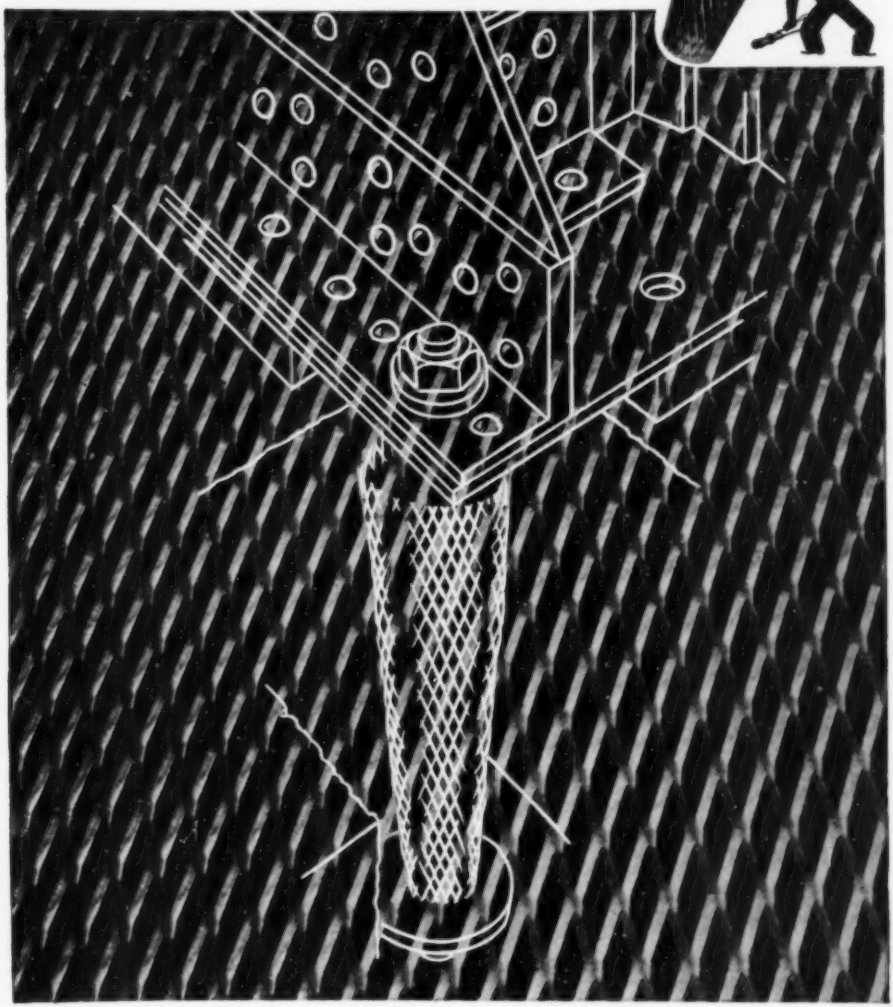

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for every process of concrete production

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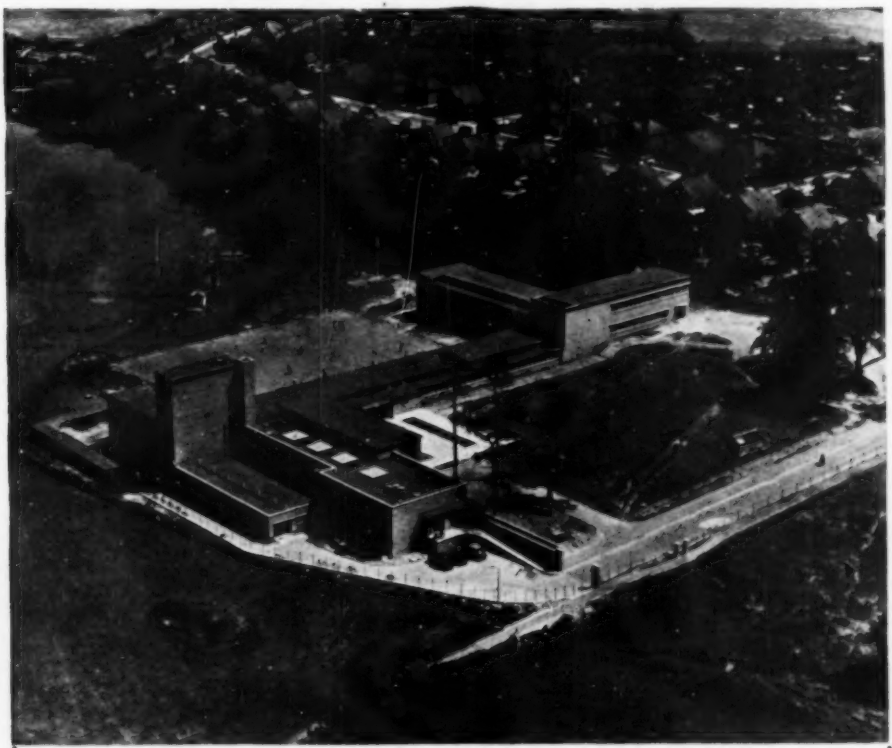

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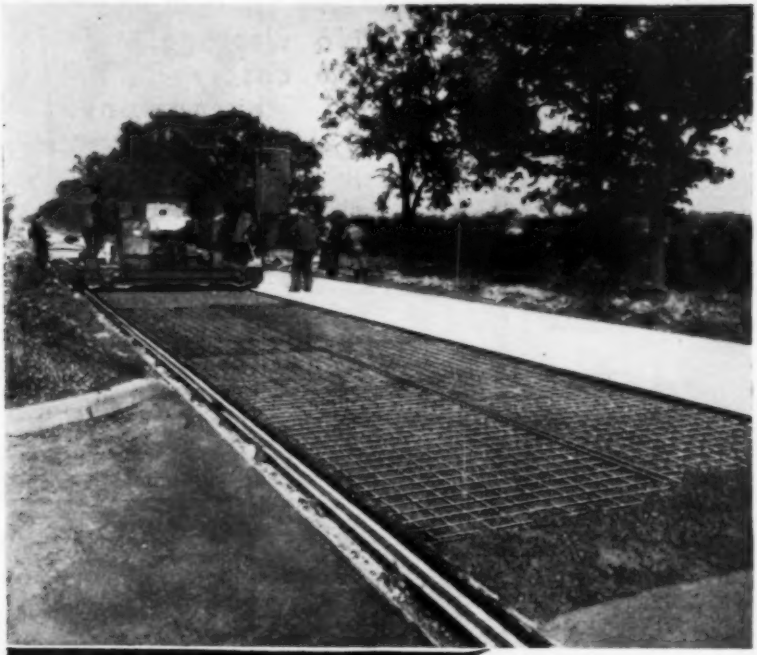

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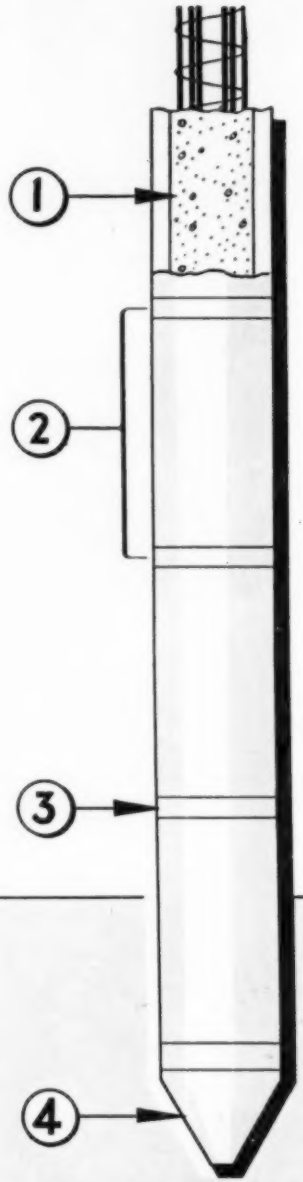

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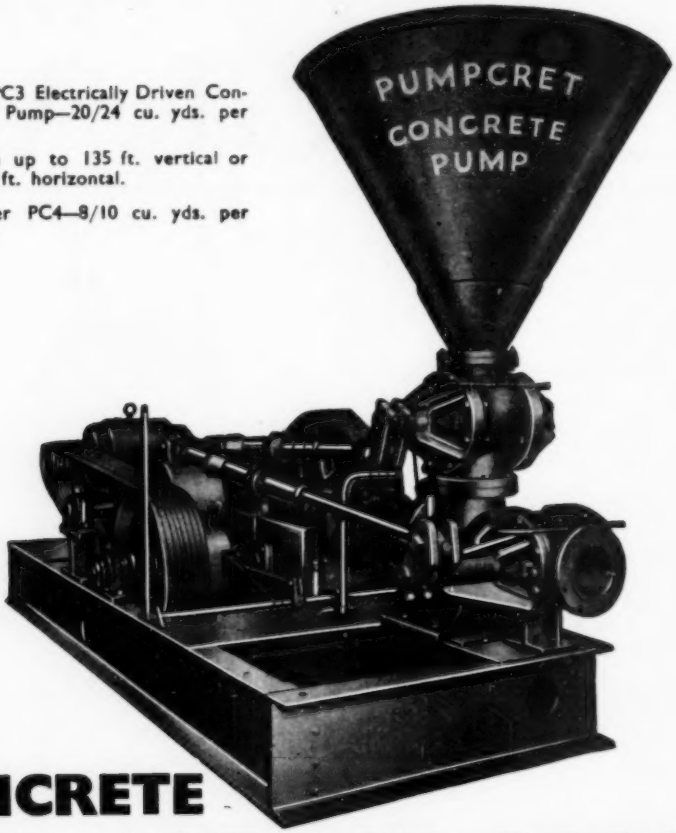

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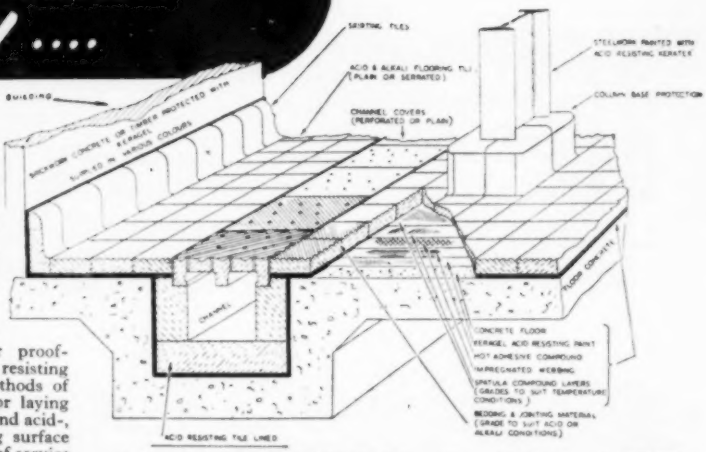
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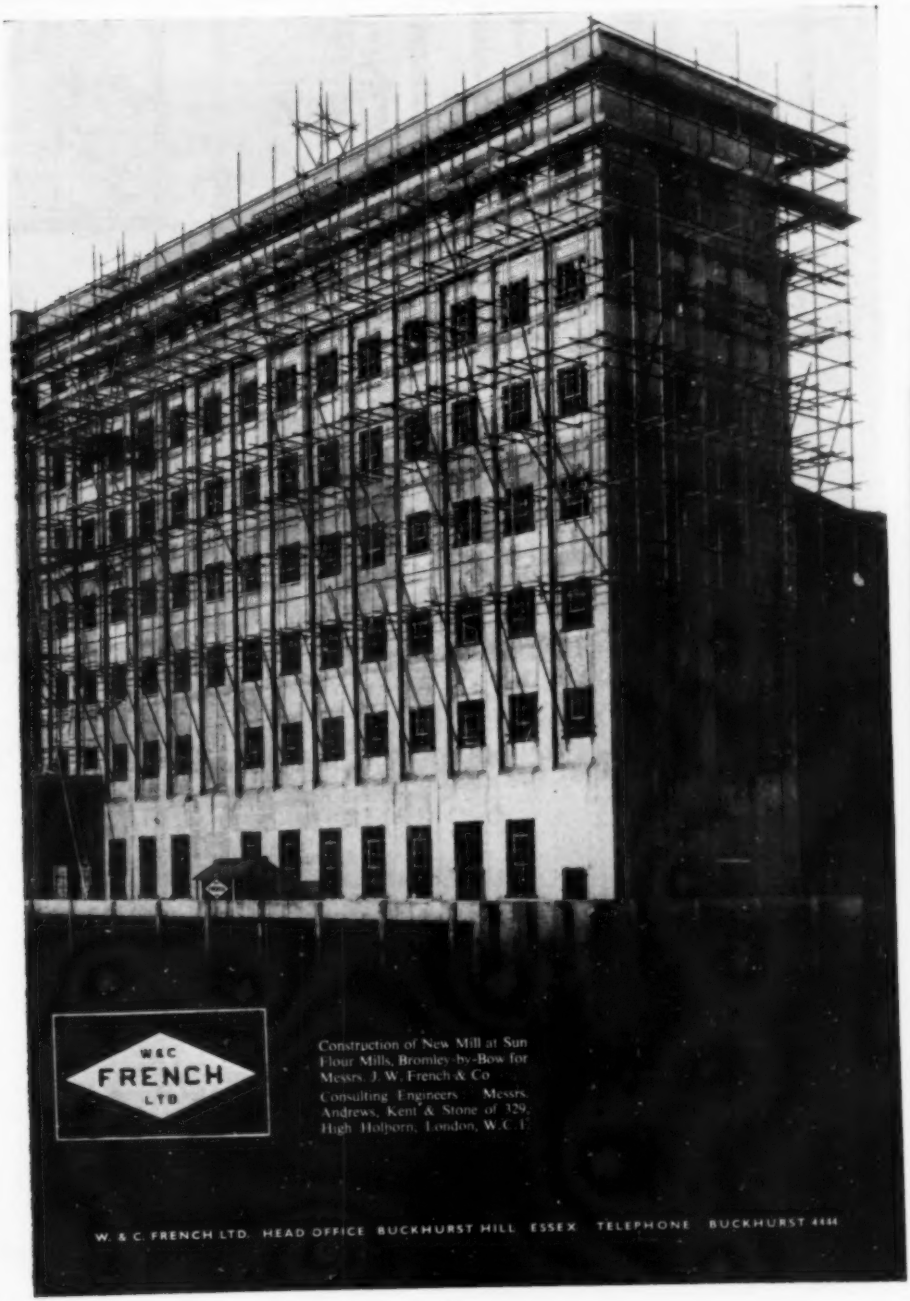
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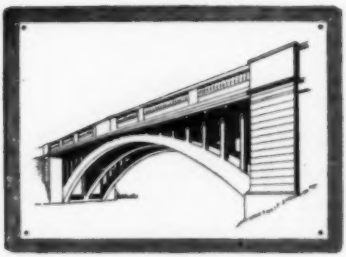
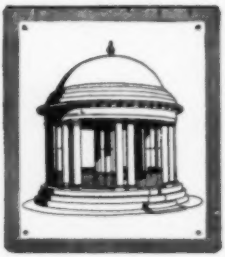
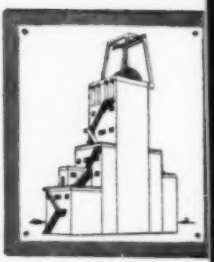
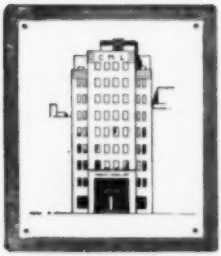
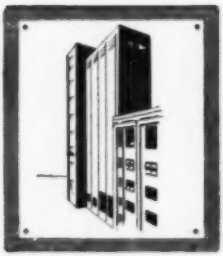
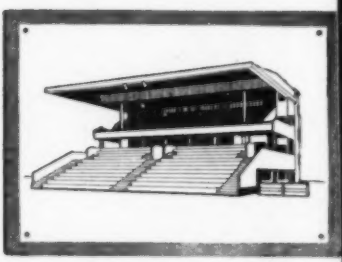




Whatever the Concrete

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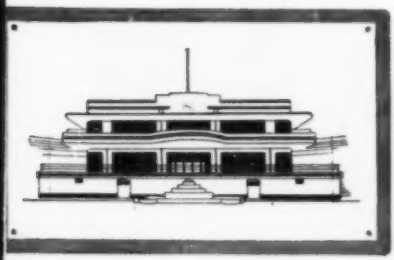
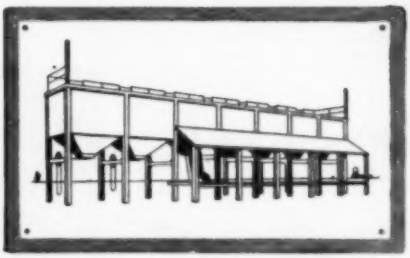
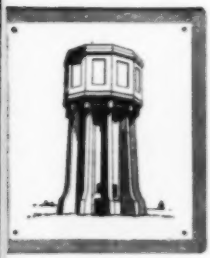
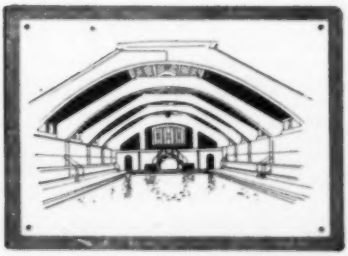
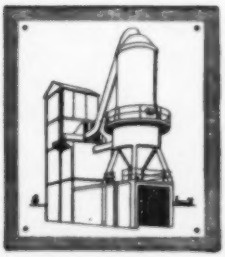




work in hand—







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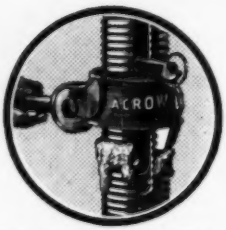

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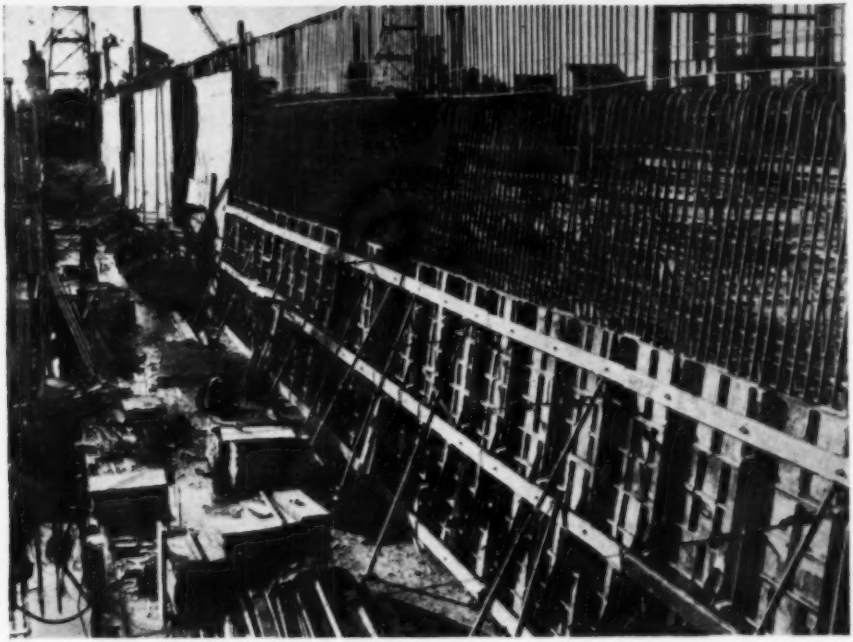

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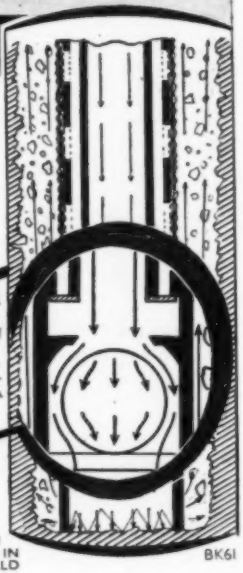

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Volume XLVII. No. 6. LONDON, JUNE, 1952

EDITORIAL NOTES

The Dictators of Durham.

THE majority of the members of the Durham County Council seem to be obsessed with the fallacy that all men are equal, and that therefore it is proper that all people in their employment should be treated in the same way. They appear to believe that, so far as conditions of employment are concerned, men whose natural ability has resulted in them being selected to control departments and who are responsible for spending millions of pounds of public money are not to be distinguished from those whose natural ability fits them for nothing better than floor sweeping. They think that there should be no difference in outlook between a professional man educated at a university and a labourer. They appear to recognise an animal called the average man, although, as Sir Alan Herbert wrote some years ago, such people have no use for the average when they need a doctor or wish to back a horse or to choose a wife—in such circumstances they seek the best and treat them with respect. This warped outlook aroused the antagonism of many of its professional employees when the Council resolved that all its employees must be members of a trade union. The history of the dispute is as follows.

Eighteen months ago the Council resolved that it be a condition of employment that all its staff should be members of a trade union or professional association. Certain professional associations resisted this proposal and, after intervention by the Minister of Education, the Council waived this requirement in the case of teachers, doctors, and dentists. The Engineers' Guild asked the Council to give similar assurances in respect of professional engineers, but this was refused. After the assurances had been given to teachers, doctors, and dentists, the Council introduced a regulation requiring applications for extended-sickness benefit to be made through a trade union or professional organisation. This was regarded as an indirect attempt to force professional employees to join a trade union or professional organisation, and so nullify the previous assurance. After unsuccessful attempts by individual professions to resolve the difference, a joint committee comprising representatives of associations representing doctors, dentists, engineers, teachers, nurses, and midwives met a committee of the Council in April last, and the Council's committee later recommended that these other professional employees be given the same assurances regarding compulsory membership as had been given to dentists, doctors, and teachers, and to the operation of sickness-benefit through representatives chosen by the professional employees. The Council, however,

refused to adopt the recommendation of its committee. In these circumstances the joint committee of the professions has asked the Ministers of Education, Health, Housing and Local Government, and Transport to assist in resolving the dispute.

The difficulty that has arisen at Durham no doubt has many origins. One may be the announcement of a former Socialist Cabinet Minister that " we are now the masters ", which may have been interpreted by some of his followers as an invitation to make life difficult for any who may be even suspected of being opposed to Socialism. This might lead naturally to the petty tyranny so often displayed by people vested with authority and who are not accustomed to, or may not be fitted for, responsibility. Whatever the cause, we have no doubt that better sense will prevail and that the Council will eventually withdraw these regulations, if it has not done so before this note is published. Some words from Cicero may be helpful to some of the members of the Council and comforting to its professional employees: " Men puffed up with a vain imagination and mistaken notions of their own great merit are exposed to the raillery of all the world, and are cheated into great and dangerous mistakes . . . Though a man should by his power and greatness overawe liberty by terror and threatenings, yet the citizens will find time to recover again . . . You will find in history frequent instances of flourishing communities which, after having been well-nigh ruined by the impetuous measures of inexperienced statesmen, have been restored to their former glory by the prudent administration of more discreet men." It is an encouraging sign that the National Union of Teachers is vigorously opposing a regulation that would increase its membership by forcing non-union teachers either to join or to resign their posts. The " closed shop " is a tyrannical manœuvre which forces association and denies freedom to remain apart from the majority. It is a denial of human rights that should have no place in a democracy. " Liberty, after she has been chained up awhile, is always most fierce and sets her teeth in deeper than she would have done had she never been restrained." So wrote Cicero as a result of experience before the Christian era began. The passage of another two thousand years has confirmed that sooner or later people will rise and destroy their oppressors, and this is well worth remembering by those who propose pettifogging regulations which curtail the freedom of choice of people or force them into associations against their will.

Although its membership is a small minority of the professions it was formed to serve, the Engineers' Guild deserves the support of the whole profession in its effort to preserve the freedom of engineers to make their own choice of whether or not they become members of a trade union or a professional association. Membership of the Guild is confined to members of the learned societies in civil, mechanical, and electrical engineering, and these bodies are prevented by their charters from taking part in negotiations on conditions of employment. Some of the professional societies, on the other hand, already deal with conditions of employment by issuing scales of fees for professional services, and some engineers in local government employment are members of trade unions such as the National Association of Local Government Officials. So far we have not heard that these professional societies or trade unions are supporting the Guild in this matter; it would give encouragement to this effort to preserve the profession from the tyranny of the " closed shop " if they had done so quickly and energetically.

Design of Singly-Reinforced Members in Bending.

By J. S. SAVONA.

To design a member subjected to bending, and reinforced in tension only, by the use of the accompanying chart the procedure is as follows:

(1) Determine the bending moment due to the superimposed load and the dead load, and select (from experience) a breadth b and a depth d.

(2) Calculate Q from $\frac{M}{bd^2}$ by slide-rule. If this value of Q is excessive, use different values for b and d and redetermine Q; this takes very little time with a slide-rule.

(3) Decide a value for c, and by slide-rule find the ratio $\frac{Q}{c}$; this equals $\frac{a_1 n_1}{2}$ and should be between 0·2 and 0·14. With this value of the ordinate $\frac{a_1 n_1}{2}$ (ordinates $\frac{a_1 n_1}{2}$ are shown on the left of the chart), interpolate the value of n_1 from curve A. The product mp is found from curve C (which gives p on dividing by m), and the value of a_1 is found from curve B.

(4) Next calculate $t = \frac{Q}{a_1 p}$, by slide-rule.

After some practice such calculations are quickly made.

EXAMPLE I.—A slab is subjected to a bending moment of 15,000 in.-lb. at the central section. The effective span is 12 ft. Design the central section assuming that it is simply supported and that $m = 15$. Assume that the depth of the slab is 6 in. and that the weight (w_s) is 72 lb. per square foot.

(*a*) The moment due to $w_s = M_s = w_s \times L^2 \times 1{\cdot}5$ in.-lb. $= 72 \times (12)^2 \times 1{\cdot}5$ in.-lb. $= 15{,}600$ in.-lb. The total moment $= 15{,}000 + 15{,}600 = 30{,}600$ in.-lb.

(*b*) $Q = \frac{M}{bd^2}$; $b = 12$ in.; $d = 5\frac{1}{2}$ in. Therefore $Q = \frac{30{,}600}{12 \times (5{\cdot}5)^2} = 84{\cdot}8$.

(*c*) Assume that $c = 600$ lb. per square inch. Therefore $\frac{Q}{c} = 0{\cdot}1413$; $n_1 = 0{\cdot}316$; $a_1 = 0{\cdot}895$; $mp = 0{\cdot}075$; and $p = 0{\cdot}005$.

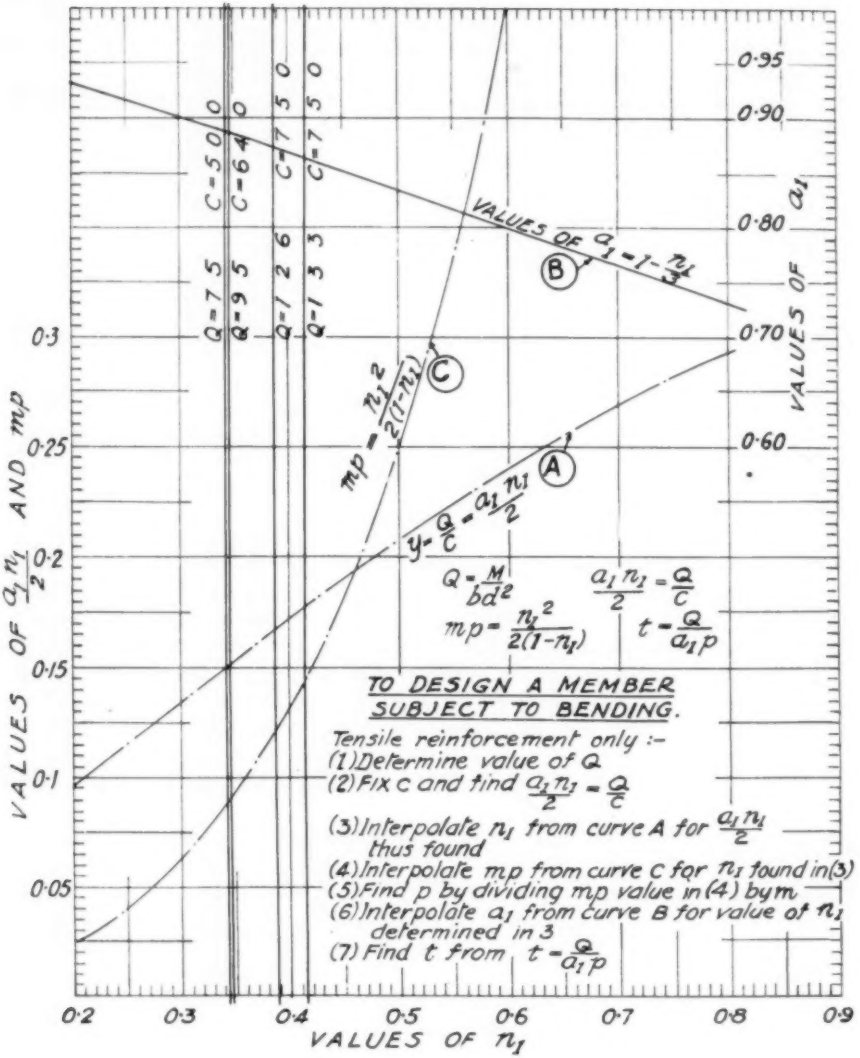
(*d*) From these values, $t = \frac{Q}{a_1 p} = \frac{84{\cdot}8}{0{\cdot}895 \times 0{\cdot}005} = 19{,}000$ lb. per square inch.

Checking a Section.

In checking a section a slightly different method is adopted.

First determine the superimposed loading and the resulting bending moment. Q is determined from $M = Qbd^2$ as explained earlier.

From known values of A_t, b, and d, calculate $p = \frac{A_t}{bd}$ and, assuming a value for m and finding mp, interpolate n_1 from curve C; next, moving parallel to the


VALUES OF $\frac{a_1 n_1}{2}$ AND mp
VALUES OF n_1
VALUES OF a_1
C-50 0
C-64 0
C-75 0
C-75 0
Q-7 5
Q-9 5
Q-1 2 6
Q-1 3 3
VALUES OF $a_1 = 1 - \frac{n_1}{3}$
B
$mp = \frac{n_1^2}{2(1-n_1)}$
C
A
$y = \frac{Q}{C} - a_1 \frac{n_1}{2}$
$Q = \frac{M}{bd^2}$
$\frac{a_1 n_1}{2} = \frac{Q}{C}$
$mp = \frac{n_1^2}{2(1-n_1)}$
$t = \frac{Q}{a_1 p}$
TO DESIGN A MEMBER SUBJECT TO BENDING.
Tensile reinforcement only :-
(1) Determine value of Q
(2) FIX C and find $\frac{a_1 n_1}{2} = \frac{Q}{C}$
(3) Interpolate n_1 from curve A for $\frac{a_1 n_1}{2}$ thus found
(4) Interpolate mp from curve C for n_1 found in (3)
(5) Find p by dividing mp value in (4) by m
(6) Interpolate a_1 from curve B for value of n_1 determined in 3
(7) Find t from $t = \frac{Q}{a_1 p}$
0·05
0·1
0·15
0·2
0·25
0·3
0·60
0·70
0·80
0·90
0·95
0·2
0·3
0·4
0·5
0·6
0·7
0·8
0·9

y-axis for this value of n_1, interpolate the value of $\frac{a_1 n_1}{2}$ from curve A; c can then be found by substituting in the equation $c = \frac{Q}{a_1 n_1/2}$.

Since a_1 can be easily found from curve B by interpolation, it is easy to determine t from the equation $t = \frac{Q}{a_1 p}$ since p is already known.

EXAMPLE II.—On a span of 14 ft. a slab 6 in. thick is reinforced with 3 in. by 16 in. long mesh according to British Standard No. 1221, Part A, No. 106. The live load is 120 lb. per square foot. As no continuity or end fixing can be relied upon, the slab is considered to be simply supported. We will check the stresses in the slab.

$M = 120 \times (14)^2 \times 1{\cdot}5 = 35{,}000$ in.-lb. $Q = \frac{35{,}000}{12 \times (5{\cdot}5)^2} = 96{\cdot}5$.

$A_t = 0{\cdot}2393$. $p = \frac{At}{b.d} = \frac{0{\cdot}2393}{12 \times 5{\cdot}5} = 0{\cdot}00364$. $mp = 0{\cdot}0653$. Assume that $m = 18$.

Interpolating for n_1 from curve C for this value of mp, $n_1 = 0{\cdot}302$; therefore $\frac{a_1 n_1}{2} = 0{\cdot}136$; $c = \frac{96{\cdot}5}{0{\cdot}136} = 710$ lb. per square inch.

From curve B, $a_1 = 0{\cdot}902$; whence $t = \frac{96{\cdot}5}{0{\cdot}902 \times 0{\cdot}00364} = 29{,}400$ lb. per square inch.

This stress in the reinforcement, though slightly excessive, is admissible when conditions permit. For example, this was on a third floor and subjected only to domestic loading.

EXAMPLE III.—A rectangular beam simply supported at the ends and having a span of 30 ft. is to be subjected to a bending moment of 840,000 in.-lb.; d is 28 in., b is 12 in., and the reinforcement is six $\frac{3}{4}$-in. round bars in tension only; $m = 12$. In the design the weight of the beam had not been included in the calculations.

The weight of the beam is $\frac{28}{12} \times \frac{12}{12} \times \frac{144}{1} = 336$ lb. per ft.

$M = 336 \times (30)^2 \times 1{\cdot}5 = 452{,}000$ in.-lb. Total $M = 1{,}292{,}000$ in.-lb.

$Q = \frac{1{,}292{,}000}{12 \times 27^2} = 148{\cdot}2$.

$p = \frac{A_t}{bd} = 0{\cdot}00817$. $mp = 0{\cdot}00817 \times 12 = 0{\cdot}09804$.

$A_t = 6 \times 0{\cdot}441 = 2{\cdot}646$.

From curve C by interpolation $n_1 = 0{\cdot}356$. From curve A, $\frac{a_1 n_1}{2} = 0{\cdot}156$.

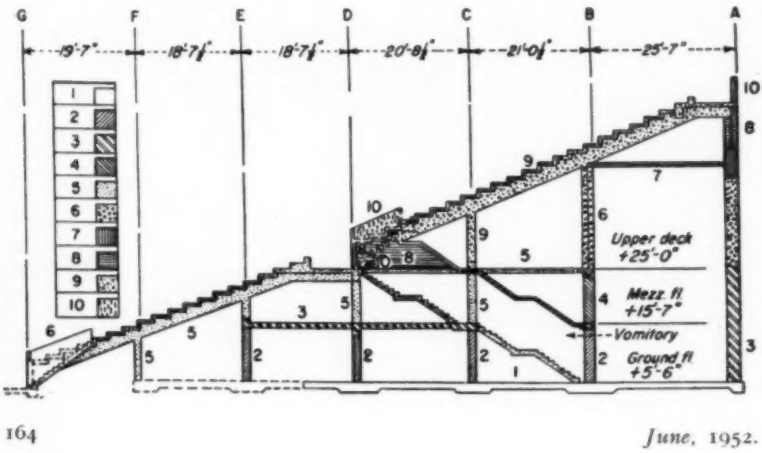
Therefore $c = \frac{Q}{a_1 n_1/2} = \frac{148{\cdot}2}{0{\cdot}156} = 948$ lb. per square inch.

From curve B, $a_1 = 0{\cdot}892$. $t = \dfrac{148{\cdot}2}{0{\cdot}00817 \times 0{\cdot}892} = 20{,}300$ lb. per square inch.

These results agree very well with checks made by other methods. Although the curves have been plotted for a considerable range of values, the more useful area of the chart is that bounded by the values of $\dfrac{a_1 n_1}{2} = 0{\cdot}2$ and $0{\cdot}14$, the corresponding values of n_1 being $0{\cdot}475$ to the right and $0{\cdot}314$ to the left. Since the values of the functions $\dfrac{Q}{c}$, a_1, and mp are read off the curves A, B, and C for one particular value of n_1, lines are drawn through the more useful values of n_1 parallel to the y-axis, and the values of Q and c for values of n_1 are written against these lines near the top left-hand corner.

The Construction of a Stadium.

THE accompanying diagram (from "Engineering News-Record") shows the ten stages in the construction of an amphitheatre containing 8200 seats at a stadium at Long Island. The structure is divided by gangways into seven segments, each of which was built independently, the same shuttering being used for each. The area of concrete surface required to be shuttered was 250,000 sq. ft., for which about 50,000 sq. ft. of shuttering were used. The total quantity of concrete is 8000 cu. yd. The procedure adopted allowed the use of short props to support the shuttering of the seats and slabs except in the case of the ceiling constructed in stage (7). This ceiling was not strong enough to carry the shuttering for the work above, so rapid-hardening cement was used which enabled the shuttering under the ceiling to be removed after three days; the slab was then re-propped to enable it to carry the shuttering for the work above. Elsewhere the shuttering was not removed as soon as possible, because most of the exposed concrete had to have a good surface and time was allowed for the concrete to shrink away from the shuttering so that the shutter boards would come away easily.



Guildford Cathedral.

REINFORCED CONCRETE FOUNDATION AND ROOF.

By BURNARD GEEN, M.Inst.C.E.

THE Diocese of Winchester, being found too large for administration, was in 1927 divided into three, namely, Winchester, Portsmouth, and Guildford. While at Portsmouth it was possible to enlarge an existing church to cathedral dimensions, this could not be done at Guildford where Holy Trinity Church is hemmed in by valuable old buildings. The decision to build a cathedral was taken, and six acres of land on the top of Stag Hill were given to the Cathedral Committee by the Earl of Onslow, and further land for the approach road was purchased. To protect the site against encroachment of future building, a considerable area of land around the site was some years later purchased and given to the Cathedral Committee by Viscount Bennett, the Prime Minister of Canada, an act of vision and great generosity.

Resulting from an open competition, five architects were selected to compete in a final competition, and in July, 1932, the design of Mr. Edward Maufe, R.A., M.A., F.R.I.B.A., was chosen. The writer was appointed consulting engineer for all the structural work in the Cathedral. The plan of the Cathedral is shown in *Fig.* 2. The extreme width of the building is 150 ft. at the west end and the internal length 365 ft.; the seating capacity is for 2,000 worshippers. The work fell into three parts, namely, (1) the construction of an approach road

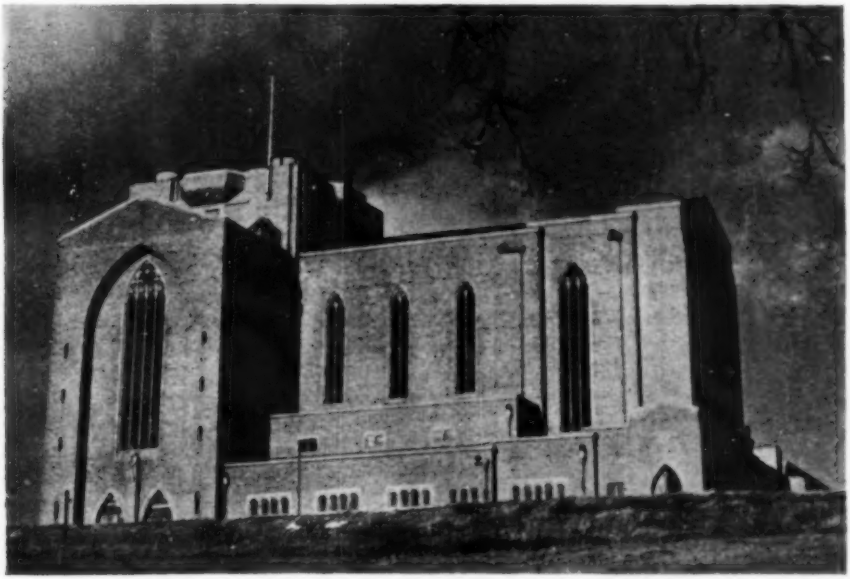


Fig. 1.—View from South.

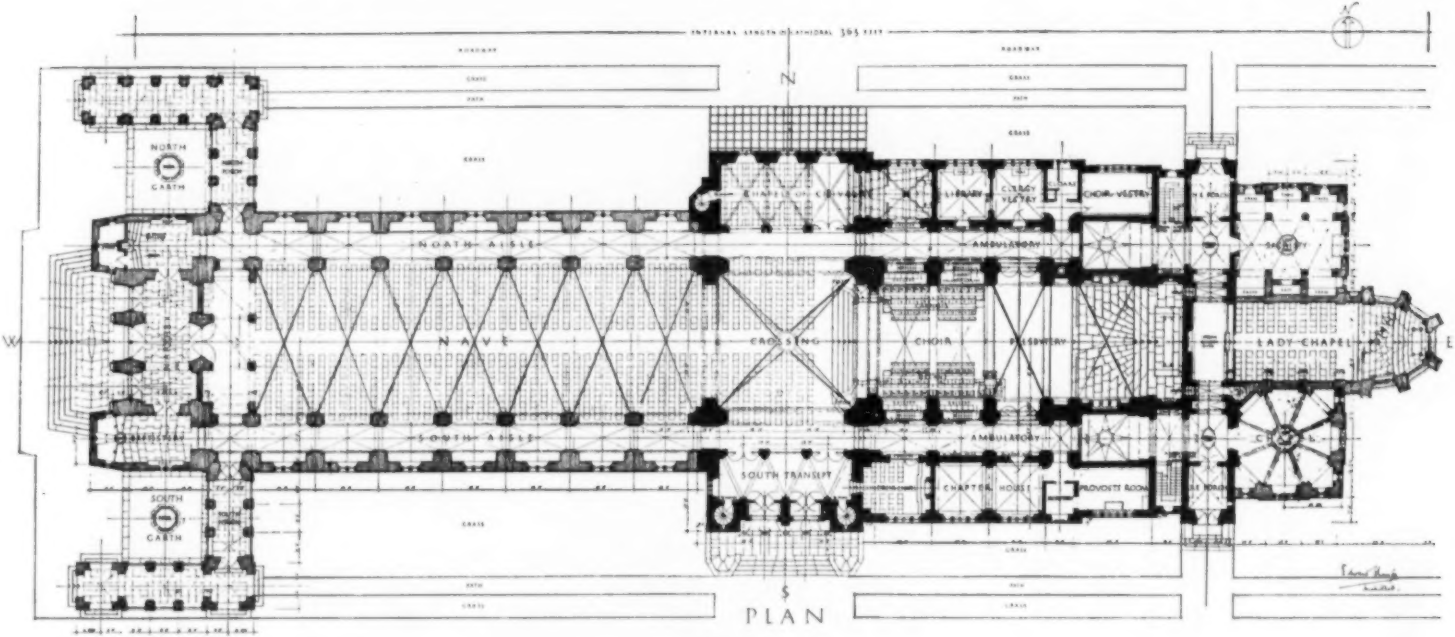

GUILDFORD CATHEDRAL
INTERNAL LENGTH OF CATHEDRAL 365 FEET
N
S
W
E
NORTH GARTH
SOUTH GARTH
NORTH AISLE
SOUTH AISLE
NAVE
CROSSING
CHOIR
AMBULATORY
LADY CHAPEL
SOUTH TRANSEPT
CHAPTER HOUSE
PROVOST'S ROOM
CHOIR VESTRY
LIBRARY
PLAN

Fig. 2.

before the foundation work could be commenced; (2) the construction of the foundations; and (3) the construction of the superstructure.

As all the reinforced concrete structural work included in that portion of the Cathedral (about one-half) now being built has been completed, this is thought to be a suitable time to give a general description of the building. Although the problems involved are in no sense of exceptional difficulty or extreme novelty, they are of a different nature from most constructional work having a strictly utilitarian purpose. The problem of building in such a fashion that, excluding violence, the work is certain to remain in good usable condition for hundreds of years is not an everyday one, and for this reason a note on the general standard of work adopted and believed to be sufficient may be of interest.

The crest of Stag Hill is about 80 ft. above the level of the Godalming–Guildford by-pass road. Within the length of the Cathedral there is practically

Fig. 3.—Forecourt and Approach Road: View from Roof of Cathedral.

no difference in level, and in the extreme width of the building there is not more than about 3 ft. fall from the centre-line to each side. The site gives fine unimpeded views in all directions and has the advantage that the long axis of the Cathedral, which coincides with the long slope of the hill, is nearly true east and west. On the south access is by a flight of steps, the slope being too steep for a road without an extension of the length by a curved route to make the slope reasonable. The road approach is from the Guildford–Godalming by-pass road to the west; the part of this approach from the by-pass road to the boundary of the Cathedral property has not yet been made by the Guildford Corporation.

The Approach Road.

From the Cathedral boundary the road now built extends a little less than one-third of a mile to the west entrance of the Cathedral. In deciding the slope of the road it was considered best to follow as closely as practicable the slope of the ground, as not only did this avoid serious disturbance of the clay soil but it

permitted a striking advantage to be obtained. The road starts about 75 ft. below the level of the forecourt and continues level for some distance; it then rises at a slope of 1 in 10·2 for a distance of about 300 ft., where it flattens out to about 1 in 40 to the forecourt (*Fig.* 3). The effect of this to an observer coming up the Processional Road is that, due to the steep slope, the main body of the Cathedral will be obscured until the end of the slope, when the building appears to rise rapidly until its full height is visible, giving a most dramatic approach. The main body of the clay below was thereby not seriously disturbed, and the 24-ft. wide road was built upon a 3-in. layer of rolled clinker and a 2-in. layer of lean concrete upon which a reinforced concrete slab, 8 in. thick at the centre and with a camber of 1 in 40 towards each side, was built. This slab is provided with expansion joints set at an angle of 80 deg. to the axis of the road; the joints are provided with copper expansion strips and steel dowels, free to move at one end. Extensive drainage was provided at each side to ensure so far as possible that the water content of the clay should remain constant, and the steep slope carries rainwater to a ditch at the foot of the bottom slope. The contract for the construction of the road and forecourt was let to Messrs. Franks Harris, Ltd., of Guildford, possession of the site was given on April 7, 1936, and the work was completed on July 13, 1936. The work comprised 1800 cu. yd. of concrete and 48 tons of steel reinforcement.

Foundation.

Seven boreholes sunk on the site of the building showed the presence of hard brown clay above blue clay, which was generally fairly level except that at the north-west corner it was about 4 ft. lower than elsewhere. The firm blue clay was at an average level of about 25 ft. below the floor of the nave, and continued for a great depth. Thirteen samples from varying depths were analysed and, while there was a trace of sulphate, no appreciable concentration was encountered and the opinion was formed that Portland cement concrete piles would remain unaffected.

It was decided to build the foundations upon 15-in. by 15-in. precast piles driven into the hard blue clay to a minimum depth of 20 ft. As all the borings showed that hard blue clay occurred at a fairly constant level it was thought that the results of driving six test piles should give a fairly accurate indication of the length required for the remaining piles. This proved to be the case, and whereas 38,779 lin. ft. of piles were made, the length driven in the ground was 38,298 lin. ft. This small amount of waste was to a slight extent due to the fact that when a pile reached its set, more than 15 in. above ground, it was driven beyond the set to make the passage of the pile frames less troublesome. A total of 778 piles was driven by a 4-tons hammer falling freely through 36 in. to a set of 12 blows to the inch. The piles were fitted with steel shoes weighing 62½ lb. and were reinforced with eight 1-in. diameter bars, tied with eight strands of $\frac{3}{16}$-in. diameter links spaced 3 in. centre to centre for the top 3 ft. 6 in. and the bottom 5 ft., and at 6 in. centre to centre between. Forks were provided 5 ft. from each end, and at 4-ft. centres between. The heads of the piles had a 1-in. chamfer and were provided with two 2-in. by ¼-in. welded steel flats recessed flush with the pile faces and spaced 3 in. and 9 in. from the top. The condition

of the heads of the piles after heavy driving gave no serious trouble. One of the piles was tested to 75 tons with less than $\frac{1}{16}$ in. settlement after 28 days, and a safe design load of 50 tons was adopted; this varied slightly for practical reasons, with 53 tons as a maximum.

CONCRETE MATERIALS.—The materials chosen for concrete making were the result of grading tests, and proportions of 27 cu. ft. of $\frac{3}{4}$-in. to $\frac{1}{4}$-in. shingle, $11\frac{3}{4}$ cu. ft. of sand, and 6 cwt. of slow-setting Portland cement were used for the general work. To assist in regularizing the water content, the sand was tipped into a pit and kept inundated; although this gave the desired result, it was discontinued in the superstructure and other means adopted. In the piles the cement content was increased to 7 cwt. with only a slight increase of the sand content, and rapid-hardening Portland cement was used. Test cubes were taken as

Fig. 4.—Reinforcement for Foundation for a Tower Pier.

frequently as seemed necessary and fairly consistent results were obtained, averaging about 4500 lb. per square inch at seven days for the piles and about 5000 lb. per square inch at 28 days for the other work.

PROTECTION OF STRUCTURAL CONCRETE.—As the excavation was in clay and the building season ahead appeared likely to be wet, and as the presence of gypsum was possible, a 1 : 6 concrete casing 3 in. thick was laid around and below all beams and pile caps, and these surfaces were coated with bitumen before casting the structural members; this removed as far as possible all sources of contamination which might affect the work in the future, and also permitted thorough consolidation of the concrete by hard ramming. *Fig.* 4 shows the foundation for one of the tower piers, on 36 piles, ready for concreting and designed to carry a load of 1650 tons.

In the deep portions of the foundations of the crypt and tunnels, where it was expected that water would otherwise in time accumulate, a generous system of drainage was provided, consisting of nests of 4-in. diameter open-joint agricultural pipes laid to a fall of 1 in 100 and covered above and at the sides with 24 in. of screened coarse shingle.

SURFACE FINISH.—Due to the heavy loads to be carried the work below ground is generally massive, and great care was taken to see that the densest possible concrete was everywhere obtained. *Fig.* 5 shows typical concrete prior to bush hammering, and *Fig.* 6 shows the excellent surface and general effect obtained after this had been done. Where lifts in the concreting occurred, no attempt was made to obscure them and the lines so produced were left to tell their tale. Below ground all surfaces which will be seen are bush hammered; the walls in the tunnels are left from the shuttering; walls above ground will be plastered to a certain height, above which the walls and ceiling will be sprayed with acoustic plaster.

PROGRESS OF THE WORK.—The contract for the foundation commenced on June 8, 1936, but due to bad weather the work was not completed until June 1938.

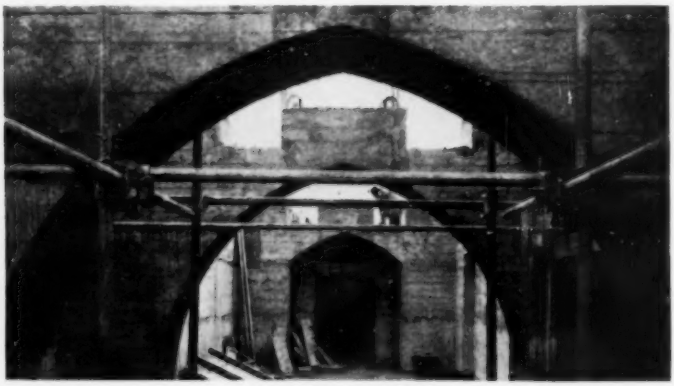


Fig. 5.—Concrete Surface before Bush-hammering.

The in-situ reinforced concrete in the foundations required 2411 cu. yd. of concrete and 156 tons of round mild steel bars. When the foundation contract was prepared it was thought that five years at most would be occupied in constructing the first part of the building up to the crossing, and, as it would be more expensive to bring the piling frames back to the site and have two relatively small contracts rather than one, the whole of the piling in all the foundation was carried out in one operation. It was fortunate that this was done, as a considerable amount of money was thereby saved. The piling was carried out by West's Rotinoff Piling & Construction Co., Ltd., as sub-contractors to Messrs. Trollope & Colls, Ltd., who were the contractors for the foundation work, and who did first-class work and gave satisfaction to all concerned.

The foundation stone, which rests upon two other stones, one each from the Cathedrals of Canterbury and Winchester, was laid by the Archbishop of Canterbury on July 22, 1936, and the dedication announced the building as "The Cathedral Church of the Holy Spirit." Queen Mary visited the site on April 1, 1937, to assist in driving the last pile. The foundation contract, including the piling, required 4830 cu. yd. of concrete and 544 tons of reinforcement.

Fig. 6.—Concrete Surface after Bush-hammering.

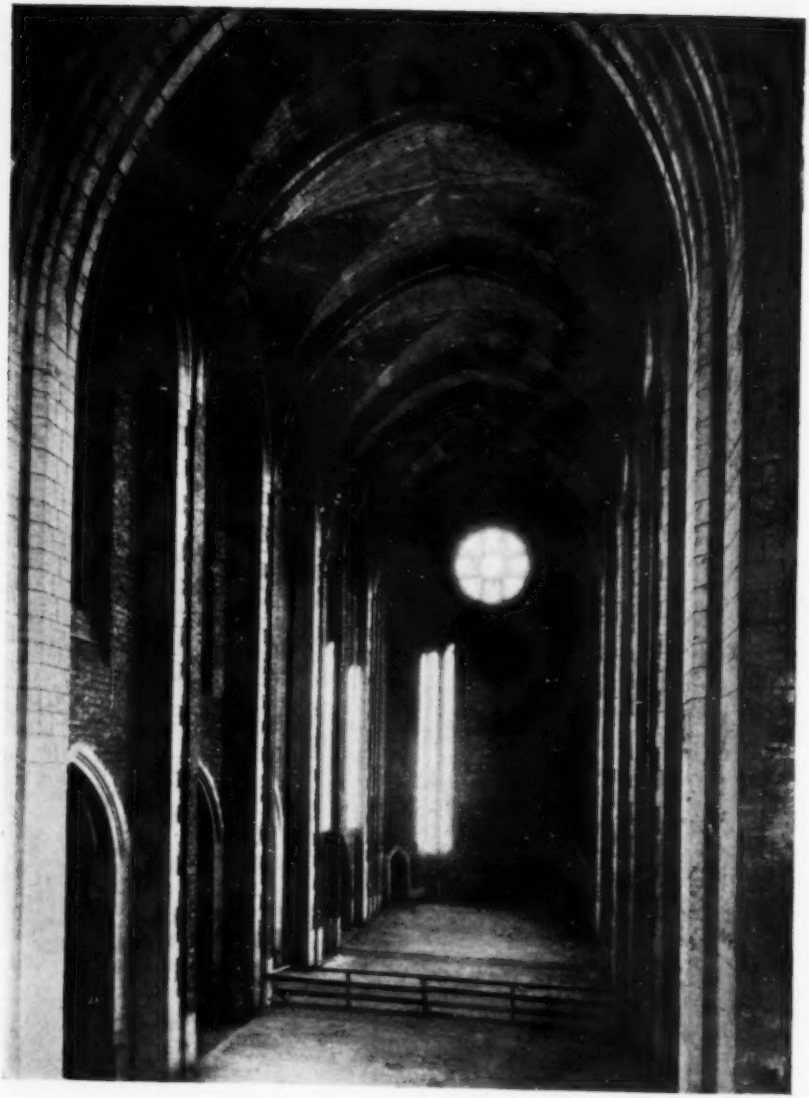


Fig. 7.—Curved Beams in Roof of Chancel.

The Superstructure.

At the conclusion of the foundation contract, it was anticipated that the first portion of the superstructure would be completed in three years. The first brick was laid by the Mayor of Guildford on May 25, 1938, but, when a good start had been made, the war intervened. Since the year 1945 restrictions on building and increased costs have further retarded progress.

The design of the structural work in the superstructure was commenced in October 1937, by which date a decision had been reached to start building such portion of the whole as the funds available permitted. The first contract for the superstructure, requiring 1511 cu. yd. of reinforced concrete and 144 tons of reinforcement, was placed with Messrs. Dove Bros., Ltd., who continued with it until September, 1939, when work was stopped, and so it remained until July, 1948, when work recommenced.

The main roof of the chancel (*Fig.* 7) consists of curved beams with a top

Fig. 8.—Twin-arch Beams in Roof of Transept.

slab covered with copper and curved vaults below, forming a hollow roof to prevent condensation and provide for the passage of workmen when required. This follows the idea adopted in the church of St. Thomas the Apostle at Hanwell, built in 1932 and carried out by the writer to Mr. Maufe's design. In the roofs over the north and south transepts the beams are exposed, and the slender two-centre pointed twin-arch form given to the beams is particularly striking where they rise to the extreme height of the roof (*Fig.* 8). At the crossing, four curved main beams carry the whole of the weight of the tower walls over the main vault, the ringing-chamber floor, the belfry floor, and the tower roof, and portions of the chancel and nave and north and south transept roofs (*Fig.* 9).

To give true form to the soffits of these beams and simplify the construction, jointed arch-stones in channel form were first erected within and upon which the beams were cast. These heavy beams were brought up level in stages on all four sides at the same time, the construction of the pendentives, where reinforcement overlaps, being a troublesome operation. The vault over the crossing is

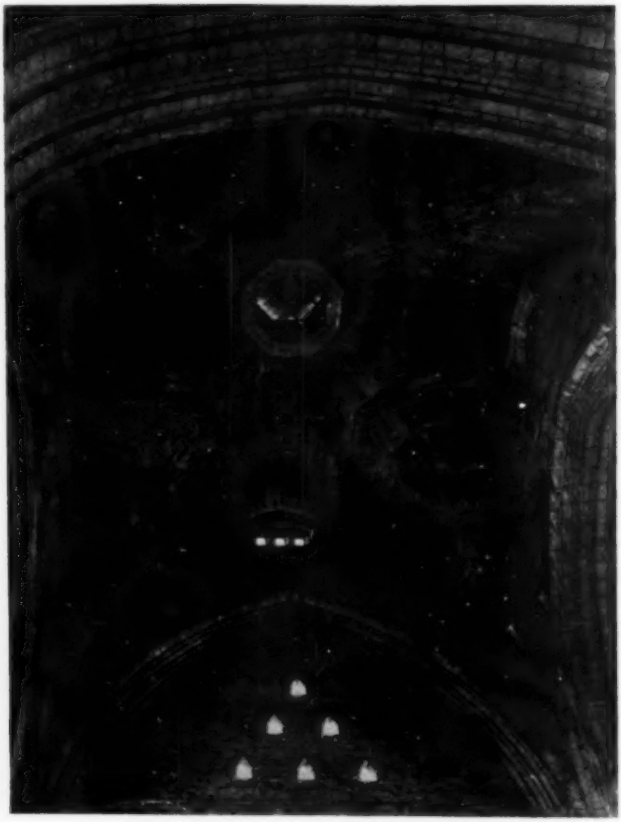


Fig. 9.—Curved Beams at the Crossing.

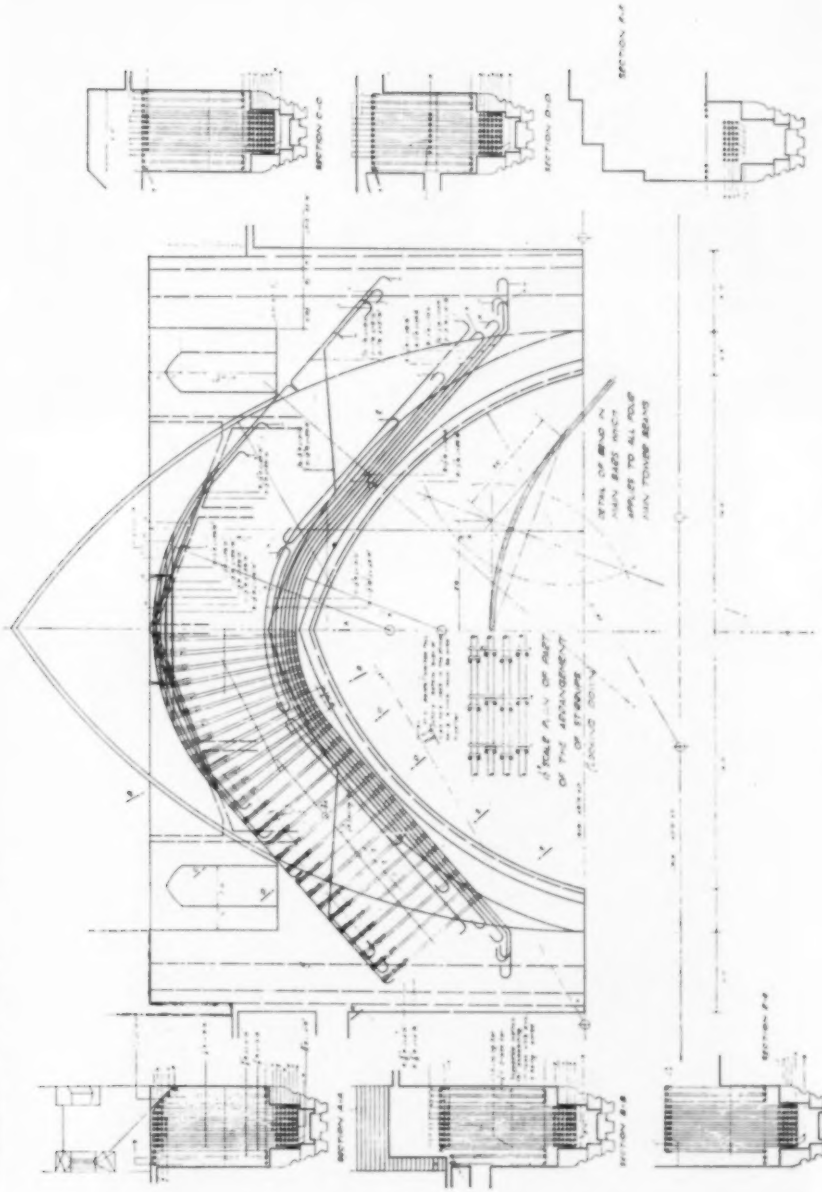


Fig. 10.—Vault over the Crossing.

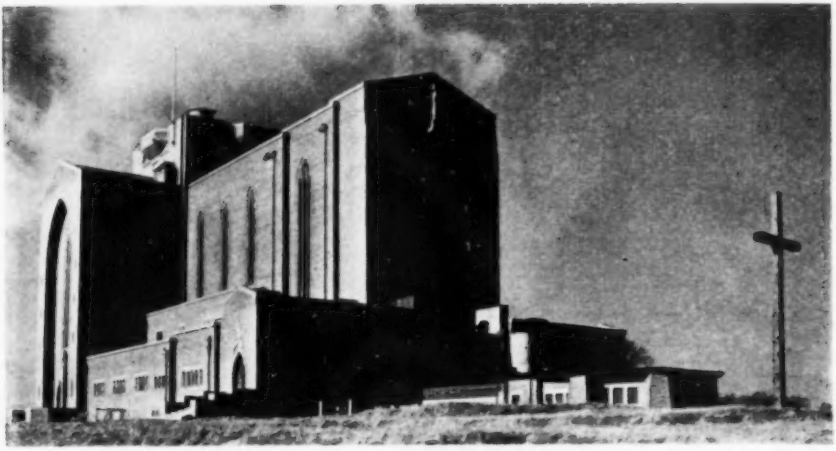


Fig. 11.—View from South-East.

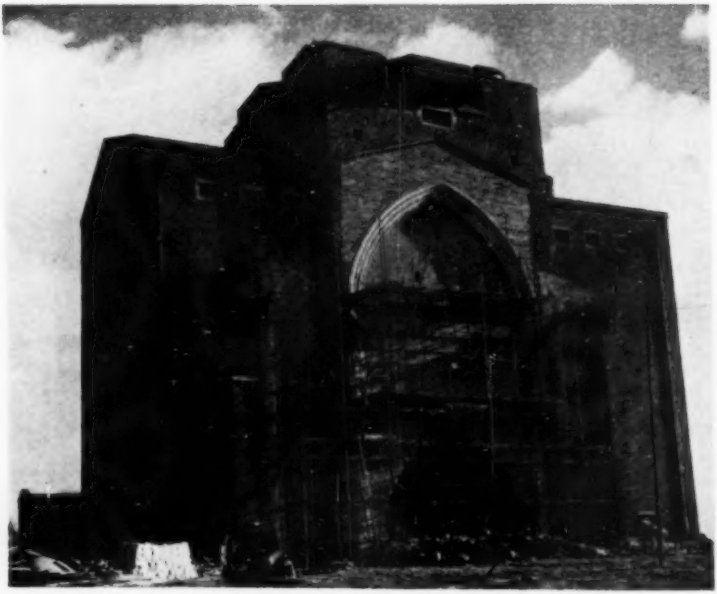


Fig. 12.—View from the West.

integral with these beams and also with the ringing-chamber floor over, the latter forming a temporary roof pending further work on the tower and adjoining nave (*Fig.* 10).

The general appearance of the building is extremely simple, free from buttresses, and an impression of loftiness is obtained. This is made possible by the construction adopted, the curved beams throughout being designed as simple free beams thereby eliminating arch thrust. This is evidenced by the simple lines of the interior, and the four main tower piers convey the same impression of slenderness, simplicity, and functionalism. *Fig.* 1 shows the elevation from the south, *Fig.* 11 from the south-east, and *Fig.* 12 from the west with the temporary west wall ready to receive folding doors.

The many varieties of shape in the vaulted roofs of aisles, transepts, Lady Chapel, and porches avoid monotony and provide great interest, and show how very suitable reinforced concrete is to such conditions. As examples, *Fig.* 13

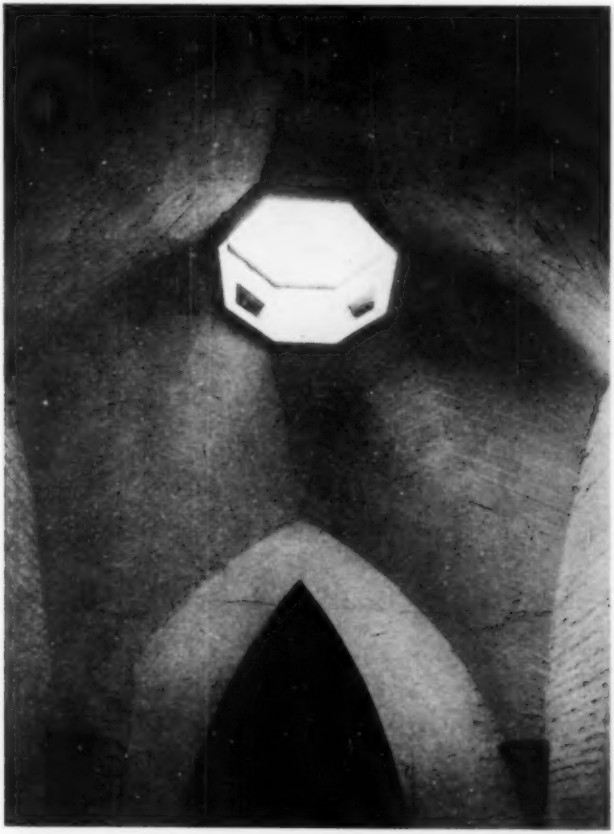


Fig. 13.—Vaulted Roof and Light over the Ambulatory.

shows the roof light over the east end of the ambulatory, a beautifully-constructed piece of work of an intricate shape; *Fig.* 14 illustrates the passage at the east end with the twin-arch beams predominating; and *Fig.* 15 shows the very complicated vaulting under the south gallery.

A characteristic of a structure such as a cathedral is that for all practical purposes the whole of the loads arising, apart from wind or snow, are dead loads, and they therefore require fairly precise calculation, especially with regard to the foundations. With such intricate shapes as the various vaults and roof forms, including double curvature, curved beams, spiral staircases, and the like, the drawing office work involved is quite out of the ordinary, requiring a highly-trained staff to deal with such work so that nothing is left to be settled on the site, the practical difficulties of construction on the site being overcome on the drawing board. This is shown in *Figs.* 17 and 18, where the bush-hammered passage to the spiral staircase and the high-level bridge were constructed to exact calculated

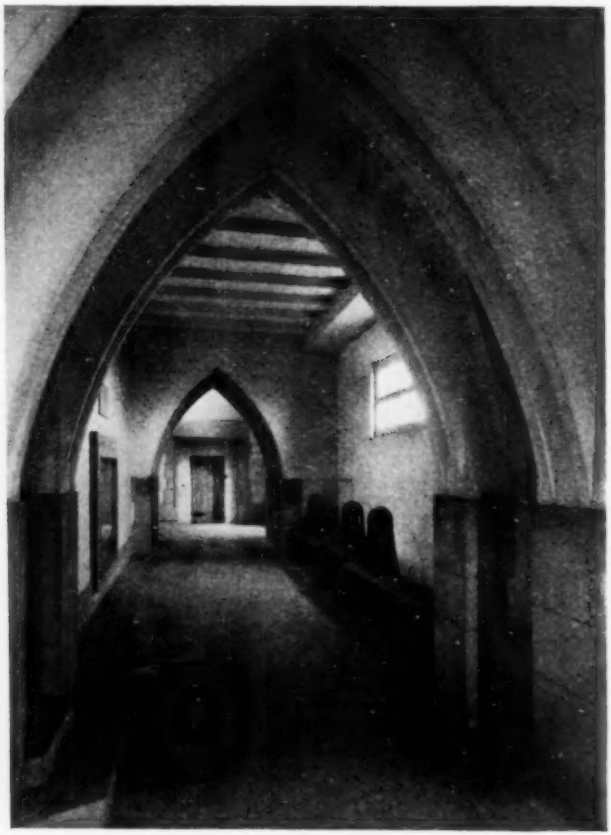


Fig. 14.—Vaulted Roof over Passage at East End.

dimensions on drawings and nothing was left to be worked out on the site. *Fig.* 16 (on pp. 182 and 183) gives a good idea of the drawing office work required in parts of the building for a very small amount of constructional work.

The first part of the superstructure built above ground extends up to the west end of the crossing, but omits the chapter house, Lady Chapel and sacristy. That is to say, on the north side it includes the Chapel of Chivalry, the library, the places for lay clerks and choristers, and the ambulatory; in the central portion it includes the area of the crossing, the choir, and the presbytery up to the altar; and, on the south side, the south transept, the children's chapel, the chapter house, the provost's room, the south-east porch, and the ambulatory.

The portion of the work below ground executed in the foundation contract includes on the north side the oil-fuel tank house, heating chamber, lavatories, chair store, and stairs in the north-east porch down to the north crypt and the choir-practice room below the future Lady Chapel; on the south side it includes the organ blower, the south crypt, chair store, meter room, lavatories, stairs to the crypt from the south-east porch, and cleaners' room, together with the cross tunnel between the heating chamber and the organ blower and the longitudinal

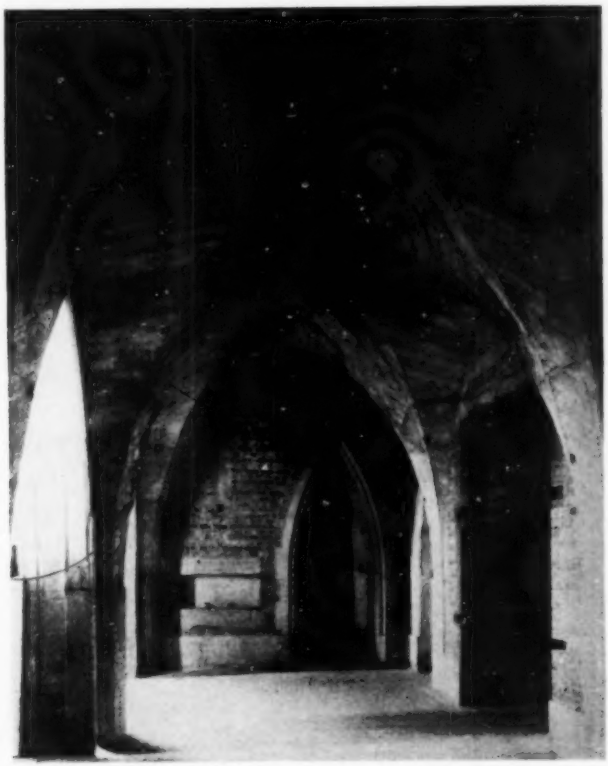


Fig. 15.—Roof Vaults under South Gallery.

central tunnel to the end of the crossing and the transverse tunnel on the centre-line of the tower.

To provide access for installation, maintenance, and repairs, or replacement of services, underground tunnels and crawling-ways are provided longitudinally along the centre of the building with three branches; expansion and contraction joints are provided at intervals, and to deal with the accumulation of water, which could otherwise develop outside, land drains are laid around all underground work.

THE BRICK FACING.—The exterior is essentially a brick design, Clipsham stone being used only for windows and copings. A wish having been expressed that the bricks should if possible be made in the Diocese, experiments were made and the Guildford Park brickworks at the foot of Stag Hill produced satisfactory bricks of clay from the site itself. The bricks are hard-burnt, of varying textures, and are rose in colour, 2¼ in. thick; they are laid in a simplified form of Monk bond rising four to a foot with a slightly recessed joint. Pavings generally will be large stone slabs, and fittings such as the pulpit and lectern will be in stone rising out of the paving. Heating via the tunnels will be in the floor from copper pipes below the paving.

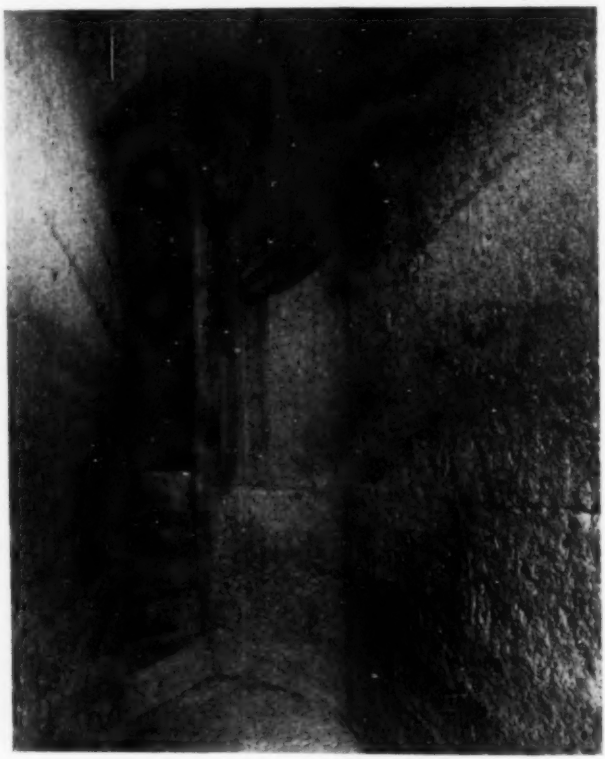


Fig. 17.—Passage to Spiral Staircase.

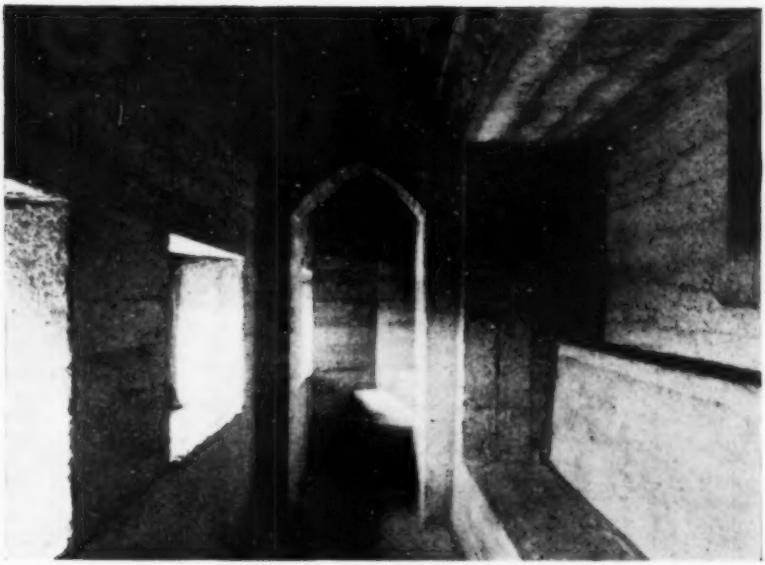


Fig. 18.—Passage to High-level Bridge.

As the pressure on the brickwork in the four tower piers and other load-carrying piers was estimated to be about 26 tons per square foot, it was necessary to see that reliable bricks were obtained, and for this purpose Lingfield engineering wire-cut bricks approximately $8\frac{3}{4}$ in. long, $4\frac{1}{4}$ in. wide, and $2\frac{5}{8}$ in. thick were employed. Tests on six bricks chosen at random showed a minimum crushing strength of 379 tons per square foot; tests were also made upon a pier $8\frac{3}{4}$ in. by $8\frac{3}{4}$ in. by $27\frac{1}{2}$ in. high built with 1 to 3 cement mortar. Tests on the mortar alone gave a crushing strength of 5035 lb. square per inch at 28 days. The pier was tested at the age of 28 days. First cracks appeared at a load of 181 tons per square foot, and total failure at 275 tons per square foot. From this it appeared that, after allowing for the slenderness ratio of the tower piers, a reasonable factor of safety was available.

FUTURE WORK.—The next intended operation is to complete the interior of this portion of the building so that it may be put into use as a cathedral, leaving the nave and west end features and the sacristy, Lady Chapel and chapter house at the east end to be added later when funds are available. Prior to 1939 building work was actively progressing, and on the basis of pre-war prices could by now have been much farther advanced; it is indeed a tragedy that, due to financial stringency and the present economic position, progress has been so much slowed down and that so many people actively engaged upon the creation of this great conception are being delayed. It is hoped that when the interior of the portion so far constructed has been completed its æsthetic appeal will cause the required additional funds to be raised and permit the completion of a magnificent conception.

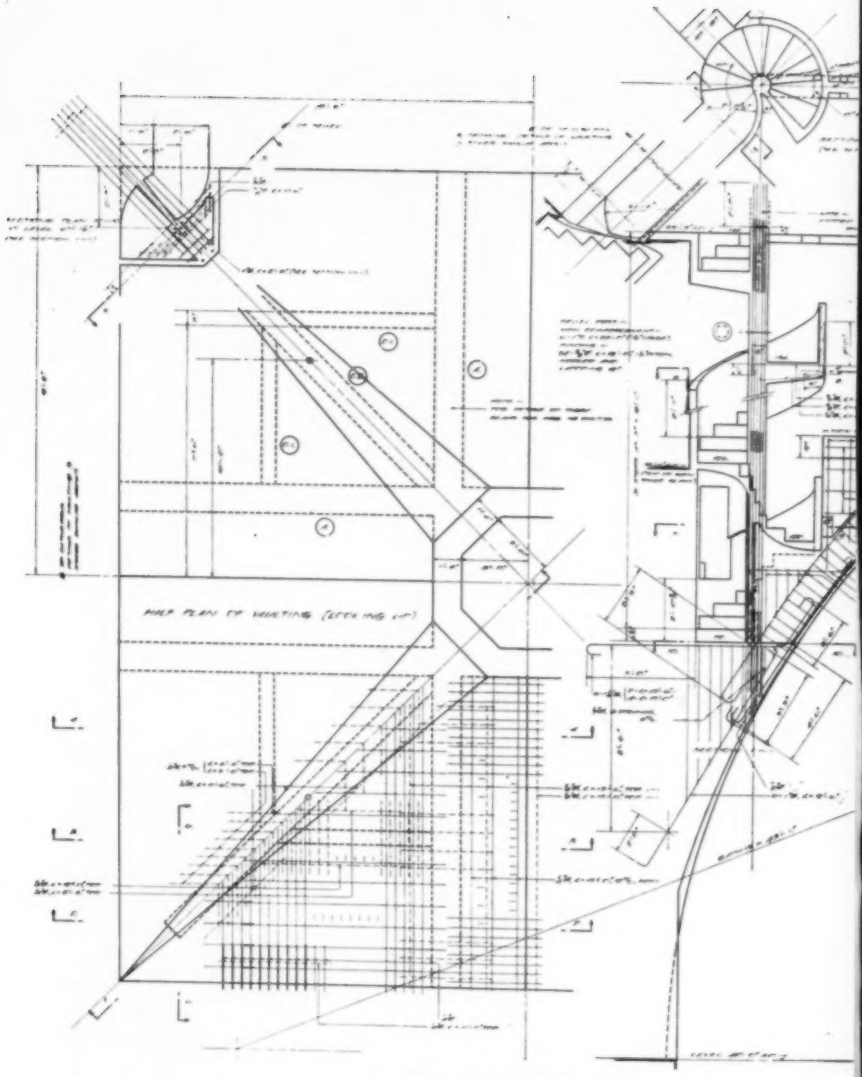
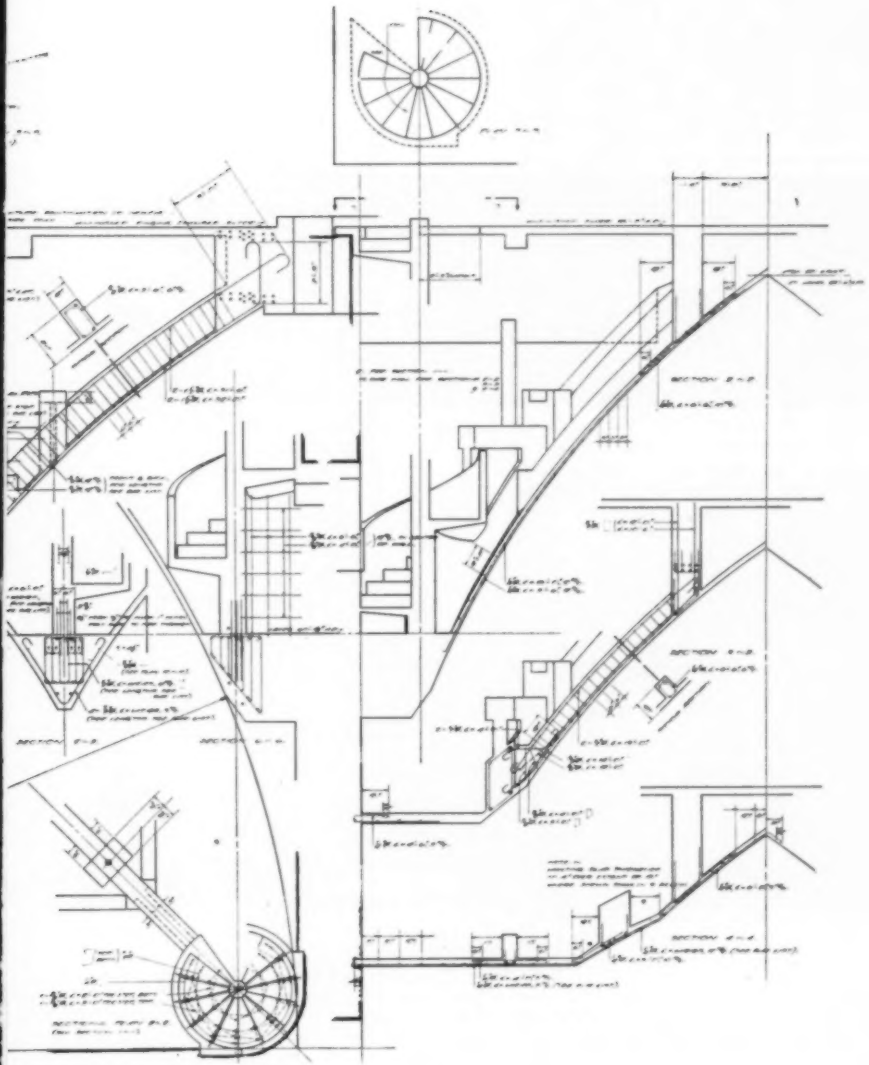


Fig. 16.—Guildford Cathedral: An Examp



of a Detailed Drawing. (*See previous pages.*)

Mobile Concreting Plant.

THE plant for mixing and placing the concrete in the yard in which are cast the blocks for the extensions at the port of Douala is described in a recent number of " La Technique Moderne ". The blocks are about 10 ft. cube. The 1¾ cu. yd. concrete mixer is in a steel tower which travels on a 10-ft. gauge track along one side of the casting yard, which is about 500 ft. long.

The concrete is transported to the moulds in a bottom-opening skip on an overhead cantilever boom about 58 ft. long, which can also be swivelled horizontally about its support at the tower. *Figs.* 1 and 2 are an end elevation and cross section of the installation. In *Fig* 2 the travel of the skip (C) is actuated by the winch (A), which is controlled by the lever (I). The tank (B) contains about 50 gallons of water, the discharge of which into the mixer is controlled by the lever (H). The aggregates and cement are brought to the mixer by the elevating skip (K) which contains about 1½ tons of material. The outlet of the mixer is at (E). The counterweight for the cantilever boom is at (J); (G) is an access ladder, and (F) is the cross-bracing for the lower part of the tower.

In *Fig.* 1, (A) is the lever by which the concrete skip is opened, and (B) is the lever by which the descent of the empty materials skip is controlled. The blocks are lifted and carried from the casting-bed by a 150-tons travelling gantry crane of 59 ft. span, one monorail of which is shown at (D–D¹) in *Fig.* 2. The dimensions in *Figs.* 1 and 2 are in metric units.

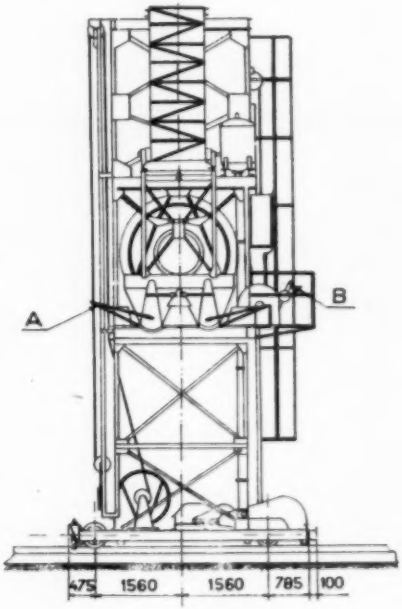


Fig. 1.—End Elevation.

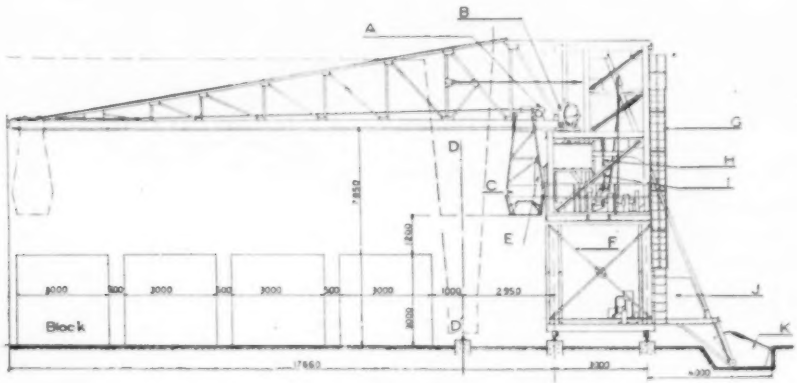


Fig. 2.—Cross Section.

Test of a Prestressed Concrete Footbridge.

THE prestressed concrete footbridge (*Fig.* 1) at the Festival of Britain site in London was tested to destruction last month. The bridge (which was described in this journal for July 1951) has a total length of 284 ft. The deck, which is 11 ft. 10½ in. wide overall and 10 ft. 4½ in. wide between the parapet fence, is 3 in. thick at the edges and less than 2 ft. thick at the centre. The columns that support it are about 17 ft. high and taper from about 3 ft. 9 in. by 2 ft. 3 in. at the top to 1 ft 9 in. by 1 ft. 6 in. at the base. The bridge was designed to carry an imposed load of 100 lb. per square foot.

An end span of 76 ft. was tested. The weight of this span was about 60 tons. On the first day of the test this span was uniformly loaded to the full design load of 35 tons; an extra load of 25 per cent. of the design load was then applied, followed by a further load of 25 per cent. of the design load. This load (150 per cent. of the design load) was left in position overnight and removed next morning. On the second day the load was gradually increased to twice the design load, and on the third day the bridge was loaded to destruction.

Fig. 1.

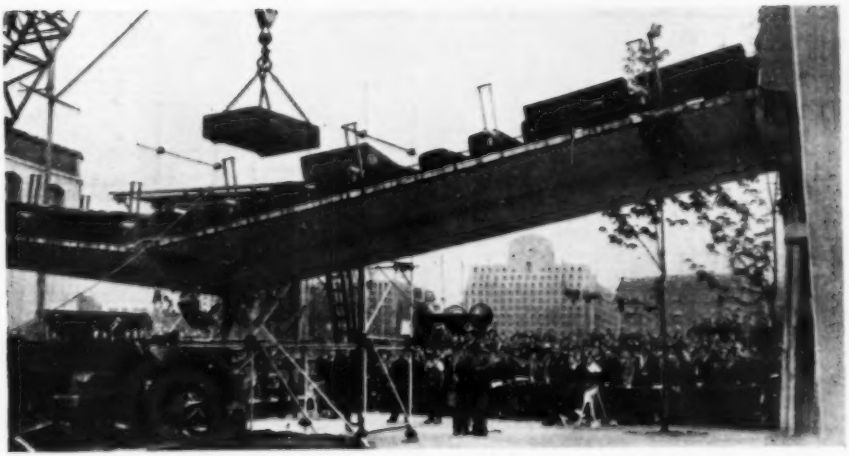
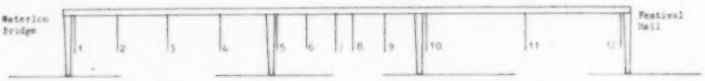


Fig. 2.

Fig. 2 shows the bridge at the time of failure.

The deflections were measured at twelve points over the length of three spans as shown at the top of *Fig.* 3. Hooks were fixed to the underside of the deck; from

these hooks, wires passed vertically to a pulley and thence, at a slight angle to the horizontal, over gauges at a distance from the bridge where the wires passed over another pulley at the end of the gauge and weights were suspended at the ends of the wires. The movement of an indicator attached to the wires over the scale gave a reading of the vertical movement of the slab at the various points. The gauge is shown in *Fig.* 6. The deflection at various loads are given in the table in *Fig.* 3. From these readings, curves of deflection (*Fig.* 4) have been drawn for the equivalent uniform live loads w calculated by equating to $\frac{wl^2}{8}$ the bending moment at the centre of a freely-supported span of 76 ft. according to the distribution of the



Position of 12 Deflexion Gauges on Prestressed Concrete Footbridge

	Load	Deflexions in centimetres 1	2	3	4	5	6	7	8	9	10	11	12	Remarks
First Day	0	-	0	0	0	0	0	0	0	0	-	0	0	
	Design Load	-	1.9	2.6	1.8	0	-0.4	-0.5	-0.4	-0.2	-	0	0	Crack near centre of loaded span, height 7 in. Also cracks on outer side of each column head supporting loaded span.
	125 per cent Design Load	-	2.7	3.7	2.4	0	-0.6	-0.9	-0.6	-0.2	-	0.05	0	Three cracks near centre of loaded span.
	150 per cent Design Load	-	3.8	5.2	3.3	0	-0.9	-1.25	-0.9	-0.3	-	0.1	0	Several cracks extending over centre ½ of span.
Second Day	150 per cent Design Load	-0.1	0.8	3.09	0.7	-0.1	-0.6	-1.1	-0.9	-0.3	0.1	0.3	0	Change with span loaded overnight. Crack over support visible. Gauge at 3 was disturbed and reading probably too large.
	Recovery on removal of 150 per cent Design Load	0.1	4.8	6.5	3.5	0.45	1.85	2.9	2.5	1.05	0.05	0.4	0.05	Approximately full recovery at 2 and 4. Initial crack visible, all other cracks closed. Incomplete recovery at 3 may have been due to disturbance of gauge.
	Reload Design Load	0.3	2.95	3.85	2.2	0.0	-0.8	-1.4	-1.2	-0.4	0.05	0.35	0.05	
	125 per cent Design Load	0.5	4.0	5.25	3.0	0.0	-0.95	-1.55	-1.3	-0.45	0.1	0.4	0.1	
	150 per cent Design Load	0.5	4.8	6.35	3.6	0.0	-1.2	-1.9	-1.6	-0.60	0.1	0.45	0.1	Cracks at last loading to 150 per cent re-opened.
	200 per cent Design Load	0.6	7.15	9.9	5.4	0.0	-1.7	-2.7	-2.2	-0.9	0.2	0.55	0.1	
	Unloading 150 per cent Design Load	0.6	6.2	8.5	4.6	0.0	-1.4	-2.3	-1.9	-0.8	0.2	0.55	0.1	
	125 per cent Design Load	0.75	5.5	7.4	4.05	0.0	-1.2	-2.06	-1.06	-0.7	0.2	0.55	0.1	
	Design Load	0.7	4.4	5.9	3.25	0.0	-0.8	-1.5	-1.2	-0.5	0.2	0.45	0.15	
	9 Tons near 2nd Support	0.5	0.6	0.9	0.65	0.2	0.3	0.3	0.4	0.25	-	-	-	Four blocks kentledge left on near 2nd support. Their removal would have required resiting crane. Three cracks visible near centre of span. One crack visible over 2nd support.
Third Day	Reload 106 lb/sq.ft.	0.25	3.15	4.1	2.1	0.2	-0.75	-1.05	-0.95	-0.4	0.05	0.15	0	Gauges set at zero with equivalent super load of 16 lb/sq.ft.
	126 lb/sq.ft.	0.4	4.3	5.4	3.0	0.2	-0.85	-1.15	-1.15	-0.5	0.15	0.3	0.1	
	146 lb/sq.ft.	0.5	5.1	6.6	3.7	0.2	-1.05	-1.4	-1.35	-0.6	0.2	0.4	0.15	
	173 lb/sq.ft.	0.7	6.8	9.0	5.0	0.25	-1.25	-1.7	-1.65	-0.8	0.25	0.5	0.25	
	200 lb/sq.ft.	0.9	9.30	12.25	6.75	0.25	-1.4	-1.95	-1.85	-0.9	0.3	0.6	0.25	Loading suspended for 1½ hours.
	200 lb/sq.ft.	1.1	9.9	13.4	7.35	0.4	-1.25	-1.85	-1.75	-0.8	0.6	-	-	Readings after 1½ hour interval.
	210 lb/sq.ft.	1.1	11.10	15.25	8.45	0.4	-1.35	-2.0	-1.8	-1.0	0.6	0.75	0.3	
	222 lb/sq.ft.	1.25	-	20.9	10.8	0.4	-1.40	-2.05	-1.9	-1.0	0.6	0.8	0.4	
	236 lb/sq.ft.	1.40	20.80	29.2	15.5	0.35	-1.3	-2.0	-1.8	-0.9	-	0.8	0.4	
	250 lb/sq.ft.													Failure
														Note: Equivalent uniform load has been calculated by equating bending moment at centre of freely supported 76 ft span to $\frac{wl^2}{8}$

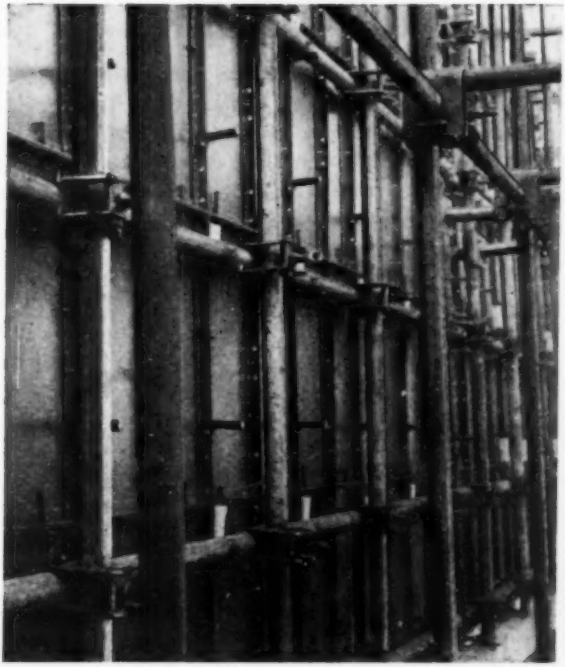
Fig. 3.

STEEL FORMS

The Multiple System of Interlocking

STEEL SHUTTERING

for in-situ concrete construction



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NO LOOSE PARTS — LOW MAINTENANCE
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Sub-contractors for Vibro piling: John Gill Contractors Ltd.

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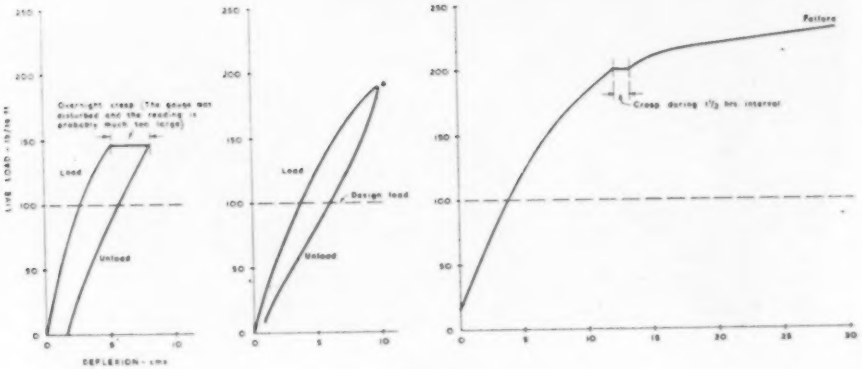
LIVE LOAD - lb/sq ft
Overnight creep (The gauge was disturbed and the reading is probably much too large)
Load
Unload
DEFLEXION - cms
Load
Design load
Unload
Failure
Creep during 1½ hrs. interval

Fig. 4.

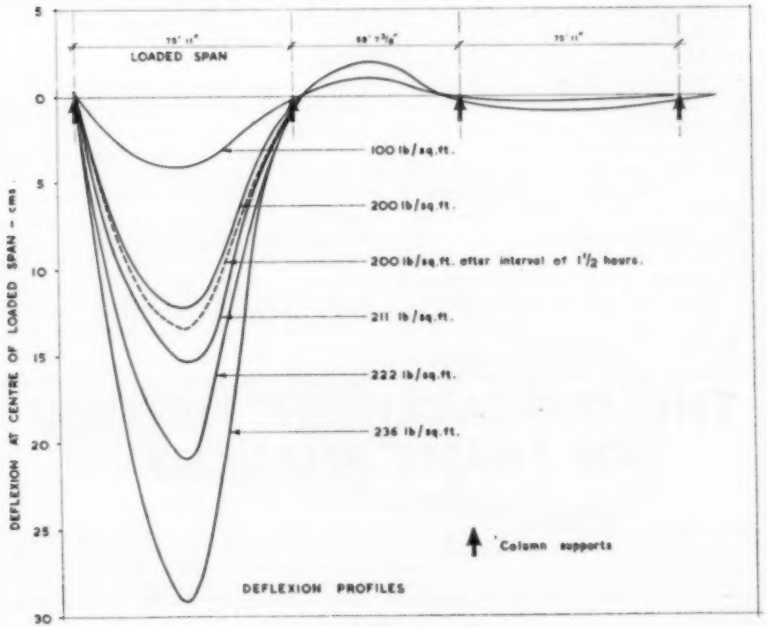
LOADED SPAN
100 lb/sq.ft.
200 lb/sq.ft.
200 lb/sq.ft. after interval of 1½ hours.
211 lb/sq.ft.
222 lb/sq.ft.
236 lb/sq.ft.
Column supports
DEFLEXION AT CENTRE OF LOADED SPAN - cms
DEFLEXION PROFILES

Fig. 5.

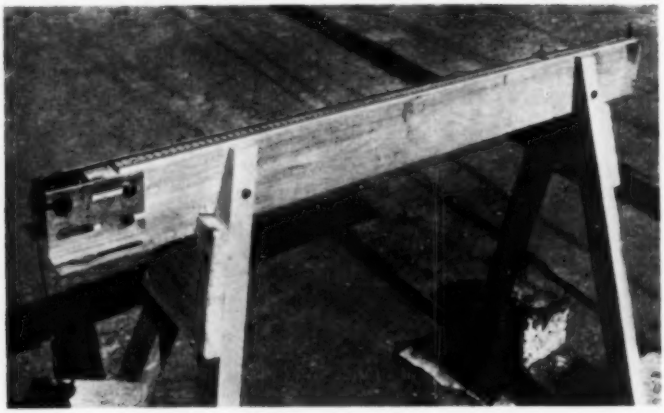

Fig. 6.

kentledge. The first curve shows the deflection when the load was increased to 150 lb. per square foot, left on overnight, and then removed. Some doubt exists of the extent of the overnight creep at the centre of the span as the gauge had been disturbed, and this is confirmed by the smaller creep shown on the gauges at the adjacent quarter-points. The second curve shows the deflection when the load was increased to nearly 200 lb. per square foot and then removed on the second day. The third curve indicates the deflection on the third day when the span was loaded to failure.

Fig. 5 shows the deflection throughout the three spans, from which it appears that the effect did not increase over the second support and beyond after loading to 200 lb. per square foot.

The structure carried a load of 84½ tons, which was equivalent to 236 lb. per square foot uniformly distributed, and failed under a load of 88 tons (250 lb. per square foot). Failure appeared to occur almost simultaneously by compression of the concrete over the second support and near the middle of the loaded span. The end column remained vertical until it was pulled over by the collapsing span. There does not appear to have been any general failure of the steel cables, but there was an absence of bond between the steel and concrete due to the failure of the grout to penetrate through from the ends.

The bridge was designed by Messrs. Ove Arup & Partners, and the test was made by Messrs. Holland & Hannen and Cubitts, Ltd., for the Cement and Concrete Association.

THE DISPLACEMENT METHOD OF FRAME ANALYSIS

By G. P. MANNING, M.Eng., M.Inst.C.E.

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Full details and many examples of the application of the "Displacement Method" of analysis of indeterminate frames, which has been proved in practice in a large design office for more than fifteen years. This labour-saving method can be applied to simple and complex frames, closed frames, and continuous beams of constant and non-constant section. Solutions are obtained by slide-rule, time is saved and the risk of errors is reduced.

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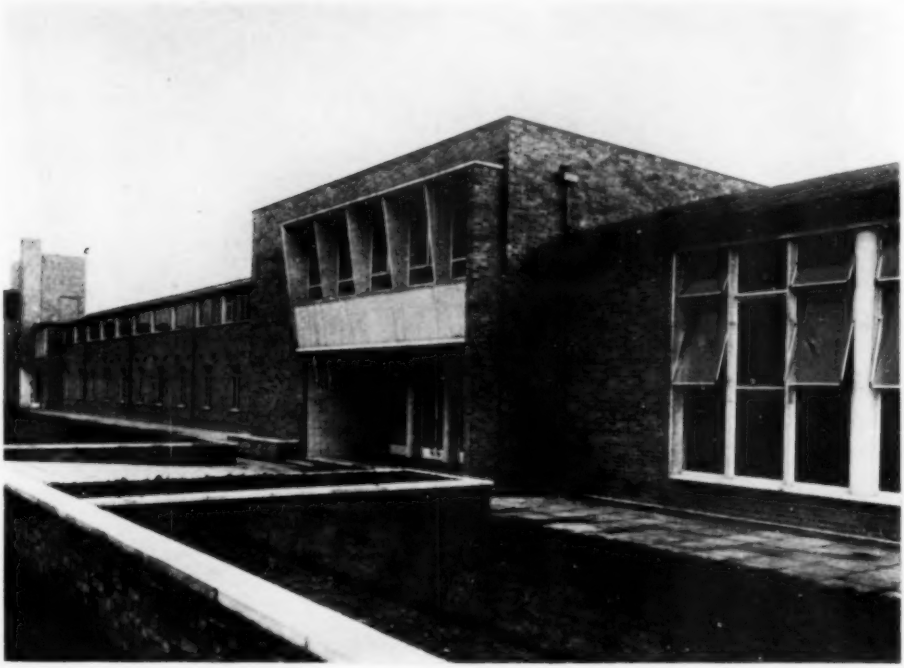

Pile Caps and Link Beams designed by Simplex Concrete Piles, Ltd. The structure illustrated above is supported by 148 SIMPLEX CAST-IN-SITU " ALLIGATOR " JAW PILES.

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Prestressed Concrete Bridge at Abertillery.

THE prestressed concrete Foundry bridge at Abertillery, Mon., replaces a steel bridge built in 1895 to carry a road over a deep railway cutting, and is carried on the old abutments and pier. The bridge (*Fig.* 1) is 40 ft. wide, with a carriageway 27 ft. wide and two footpaths each 6 ft. 6 in. wide. There is one span of 71 ft. 6 in. and another of 61 ft. 6 in., five beams in each span carrying a reinforced concrete deck.

The beams, which are 73 ft. 6 in. and 63 ft. 6 in. long, were cast on a base large enough to make three at a time. The shutters were made for the longer beams, and a part was cut out of the centre to make the shorter beams. Ducts for the straight prestressing cables were formed with inflatable tubes, and steel tubes were used for the curved ducts. The Freyssinet system was used, the longer beams containing twenty-four cables and the shorter containing eighteen cables. Each cable comprises twelve 0·2-in. diameter wires.

The concrete had an average cube strength of 5171 lb. per square inch at seven days. The first beam was stressed 22 days after casting and moved into position 14 days later. Partial prestressing was applied on the casting bed and full prestressing when the beams were in position and carrying the deck.

Moving the beams into position was facilitated by the fact that the new bridge was higher than the old one, and the existing cross-bearers (no longer supported on the steel parapet beams, which had been removed, but on timber struts) were used to carry the beams. The beams were lifted at each end on to a small trolley, which travelled on a railway track, and were pulled to their approximate position (*Fig.* 2). The beams were moved sideways into position by being suspended from frames erected on the abutments and on the central pier. When all the beams were in position, transverse beams were cast between them; the transverse beams act

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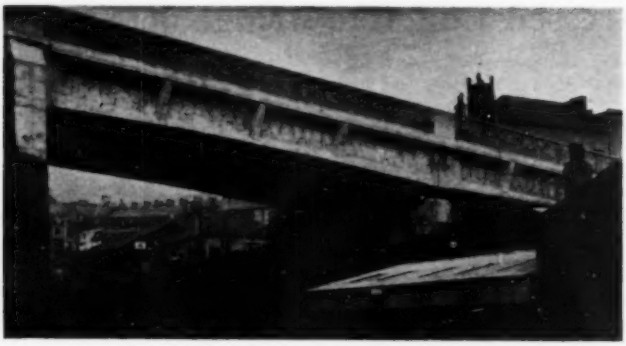

Fig. 1.

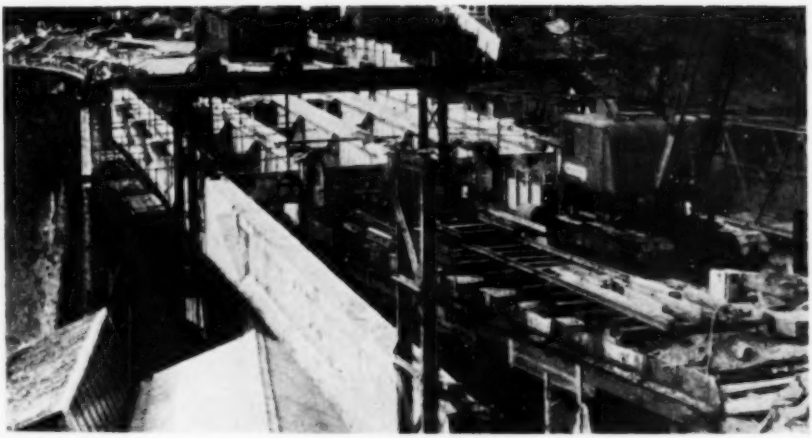

Fig. 2.

as stiffeners, and are provided with precast ends on the outside of the outer girders to house the anchorages of the two prestressing cables in these beams. After the transverse beams had been prestressed the deck was concreted. The beams were moved from the casting bed to their approximate position in less than half-an-hour; placing the beams in their final position generally took rather longer. The whole of the work was completed in about twelve months.

The cost was borne jointly by the Monmouth County Council and the Ministry of Transport; the Abertillery U.D.C. acted as agents for the County Council. The consulting engineers were Messrs. Wallace Evans & Partners and the contractors Sir Robert McAlpine & Sons (South Wales), Ltd.; the prestressing work was done by the Vibrated Concrete Construction Co., Ltd.

Steel Sheet Piling.

THE Appleby-Frodingham Steel Company (branch of The United Steel Cos., Ltd.) have added to their range of steel sheet piling a new section with a minimum thickness of 0·45 in. and a lock centre of 15¾ in. The section is 10¾ in. deep. It has a weight of 40·98 lb. per square foot of piled wall and a modulus of 43·75 in.³ per foot of wall.

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SITUATIONS VACANT.

SITUATIONS VACANT. Civil engineer with first-class experience in design of heavy foundations and all types of reinforced concrete structures required for senior appointment with consulting engineers in Newcastle-upon-Tyne area. Applications are also invited for several posts for designer-detailers from applicants having previous experience in design and detailing of similar works. Salaries commensurate with qualifications and experience. Apply, giving particulars of age, experience, and salary required, to BOX 2545, CONCRETE AND CONSTRUCTIONAL ENGINEERING, 14 Dartmouth Street, London, S.W.1.

SITUATION VACANT. Consulting structural engineer, Westminster, requires a senior designer-draughtsman with first-class experience in reinforced concrete and/or structural steelwork for responsible position. High salary and good prospects for suitable applicant. Write in confidence, stating age, qualifications, and full details of experience. BOX 2552, CONCRETE AND CONSTRUCTIONAL ENGINEERING, 14 Dartmouth Street, London, S.W.1.

SITUATION VACANT. Research engineer. Unit Construction Co., Ltd., require for their research office at Feltham, Middlesex, a young graduate to do experimental work on new techniques and materials for building, especially developments in, and quality control of, production of prestressed concrete. Some design or research experience would be helpful. Commencing salary £500. Write to 34 St. James's Street, London, S.W.1.

SITUATION VACANT. Beecham Buildings, Ltd., Reinforced Concrete Engineers, Shipston-on-Stour, Warwickshire, require senior assistant structural engineer. Should be A.M.I.Struct.E. or equivalent, and have a sound experience in structural design and reinforced concrete detailing. The firm specialises in design, manufacture, and erection of industrial and other buildings embodying a wide variety of semi-standardised precast concrete components. This is an opportunity offering excellent prospects to a keen young engineer of proved capacity. Excellent flat available. Apply to the address given above, giving full particulars of age, training and experience.

SITUATION VACANT. Experienced designer (senior) required for Nairobi, Kenya, by long-established company of reinforced concrete specialists employed primarily on design of commercial structures. 44-year contract (renewable), with paid passages. Home leave and pension scheme. Write Box MY/56, c/o 95 Bishopsgate, London, E.C.2.

SITUATION VACANT. Wanted. Junior designer-draughtsman for precast and prestressed concrete work. Age 22–25. Applicants must have some experience in reinforced concrete design and sufficient technical knowledge to acquire prestressed concrete design quickly. Preference will be given to a man with previous training in mechanical office. Salary according to age and experience. Apply THE CHIEF DESIGNER, DOW-MAC (PRODUCTS), LTD., Tallington, near Stamford, Lincolnshire.

SITUATIONS VACANT. The Trussed Concrete Steel Co. Ltd., Truscon House, 35–41 Lower Marsh, London, S.E.1, require additional staff in their London and Manchester design offices : (*a*) Designer-Detailers (age 25 or over), (*b*) Detailer-Draughtsmen (age 20 or over). Previous good experience in reinforced concrete drawing office is important. Five-day week and pension scheme. Apply in writing to the above address giving full particulars of age, education, and previous employment.

SITUATIONS VACANT. Reinforced concrete engineers have vacancies in their Bristol office for designers. Preference will be given to applicants with good previous experience, but any suitably qualified person will be considered for training. These posts offer opportunities in all types of structures. Give fullest details when replying. BOX 2555, CONCRETE AND CONSTRUCTIONAL ENGINEERING, 14 Dartmouth Street, London, S.W.1.

SITUATIONS VACANT. Two draughtsmen required for a prestressed concrete factory in Essex. Must have had practical experience in reinforced concrete work. Apply in writing, giving full details of age, experience, and salary required, to BOX 2553, CONCRETE AND CONSTRUCTIONAL ENGINEERING, 14 Dartmouth Street, London, S.W.1.

SITUATION VACANT. Chief designer required by consulting structural engineers, Westminster. Considerable experience of reinforced concrete buildings essential, and experience of structural steelwork desirable. Applications in confidence, stating age and qualifications, with full details of experience. BOX 2556, CONCRETE AND CONSTRUCTIONAL ENGINEERING, 14 Dartmouth Street, London, S.W.1.

SITUATION VACANT. The Stanton Ironworks Company proposes to appoint a concrete research engineer, and applications are invited from suitable candidates. The person appointed must be qualified to take charge of concrete research and quality control on their concrete plant, in respect of both normally reinforced and prestressed concrete. Applicants should state their age, qualifications, experience, and salary expected, and address their applications to THE STAFFING OFFICER, THE STANTON IRONWORKS CO., LTD., near Nottingham.

SITUATION VACANT. Draughtsman experienced in detailing reinforced concrete work required by large firm of civil engineering contractors for London and South Wales Offices. Write Box C.E.245, at 191 Gresham House, London, E.C.2.

SITUATION VACANT. Junior engineer required by firm of prestressed concrete manufacturers in Liverpool. Experience in design and draughtsmanship an advantage. Commencing salary £450 per annum. Write, stating age, and particulars of experience, to BOX J 406, LEE & NIGHTINGALE, NORTH HOUSE, NORTH JOHN STREET, LIVERPOOL.

SITUATIONS VACANT. Civil engineering assistants required by Westminster consultants. Age range preferably 25–30. Four years' experience, and preferably A.M.I.C.E. Applications are invited in confidence, and subsequently interviews will be arranged for selected applicants. Please indicate preference for (a) Design work in London, (b) Site work in United Kingdom, or (c) Site work abroad. Several vacancies will be available during the next few weeks. BOX 2557, CONCRETE AND CONSTRUCTIONAL ENGINEERING, 14 Dartmouth Street, London, S.W.1.

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SITUATIONS VACANT. The British Reinforced Concrete Engineering Co. Ltd., require several qualified designers with specialist experience for their Stafford, London, Bristol, Glasgow, and Newcastle-upon-Tyne offices. Five-day week, and staff pension scheme. Apply to B.R.C. ENGINEERING CO., LTD., Stafford.

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SITUATIONS VACANT. Structural draughtsmen with experience of reinforced concrete detailing required in London office of Norman & Dawbarn, Architects and Consulting Engineers, 5 Gower Street, London, W.C.1. Reply stating age, experience, and salary required.

SITUATIONS VACANT. Experienced reinforced concrete detailers required. Good opportunities for design. Contractors' office, Victoria area. BOX 2558, CONCRETE AND CONSTRUCTIONAL ENGINEERING, 14 Dartmouth Street, London, S.W.1.

(*Continued on page* lvi.)

MISCELLANEOUS ADVERTISEMENTS.

(*Continued from page* lv.)

SITUATIONS VACANT. Reinforced concrete designers, detailers, and draughtsmen required for London office, mainly for work in connection with reinforced concrete floors (precast and in situ). Write stating age, experience and salary required to Box C.E. 286, 191 Gresham House, London, E.C.2.

SITUATIONS VACANT. A company specialising in the design of reinforced concrete buildings requires an engineer for site inspection of work carried out by contractors to the company's design. Applicants should have held responsible positions as resident engineers or agents for reinforced concrete constructional work. Visits to sites in all parts of the country will be entailed. Some design experience is desirable. Write giving details of age, experience, and salary required to Box C.E. 287, 191 Gresham House, London, E.C.2.

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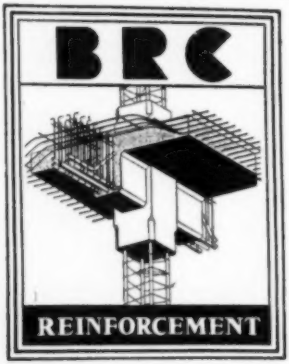

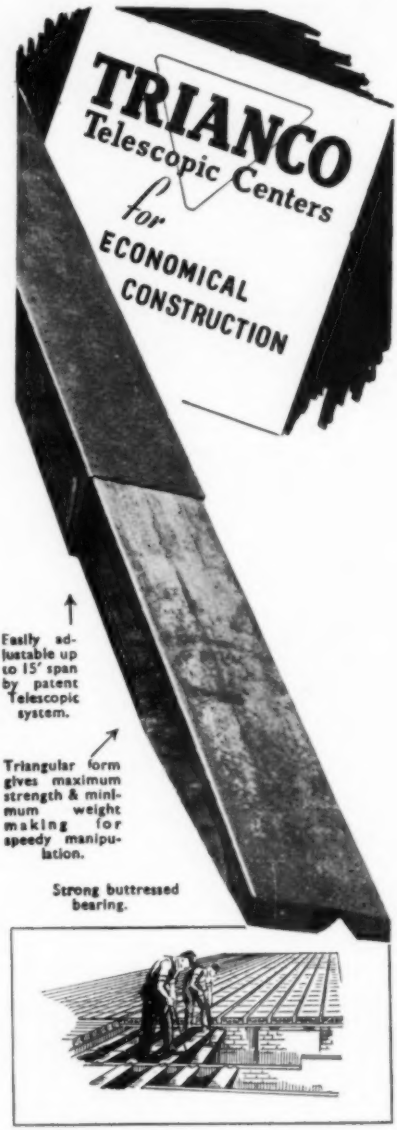

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Book Reviews.

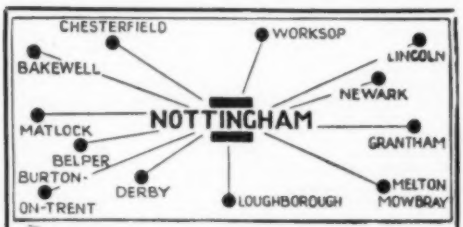
"Anschautiche Verfahren zur Berechnung von Durchlaufbelken und Rahmen" (Ausgleichverfahren). By R. v. Halasz. (Berlin: Wilhelm Ernst & Sohn. 1951. Price 31.50 D.M.)

METHODS of calculation of continuous beams and frames by the dispersal of residual fixity moments through successive approximations where the same routine, which is largely self-checking, applies to all types of structures, are, according to the author, being widely adopted on the Continent. It is claimed that much of the arithmetical work can be done by partly-trained staff under the supervision of an experienced engineer. The author gives a summary of the methods originated by Professor Hardy Cross, and their use is illustrated by examples. However, in the method suggested great care must be taken in establishing the correct values of moments and forces on complicated frames subject to sway, and under such conditions it is likely that some of the more familiar methods give quicker results. Many useful diagrams are given for the calculation of beams with haunches at one or both supports, and of beams having varying moment of inertia throughout. Values of the support moments for uniformly, partially, and fully distributed loads are given, and for concentrated loads in any position suitable for the construction of influence lines. Diagrams are also given for stiffness and dispersal coefficients. With these data the method can be readily applied to beams of varying moment of inertia without much extra work.

"Das Betonieren bei Frost." By F. Böhm and W. Drechsel. Fifth edition. 1951. (Berlin: Wilhelm Ernst & Sohn. Price 7.50 D.M.)

THIS small book describes winter construction methods as practised in the colder parts of Europe. In the first chapters the theoretical principles are discussed, followed by suggested methods of reducing loss of heat in concrete materials and freshly-placed concrete. The recommended methods do not differ materially from those used in Great Britain, and may be summarised as follows.

Cements which harden rapidly and develop high setting temperatures are suitable. High-alumina cement is almost immune to low temperatures, but the period of mixing should be extended so as to accelerate internal heat generation. An increase of cement content, and reduction of the amount of mixing water by suitable grading resulting in stiff mixtures which can be consolidated by vibrators, reduce heat losses. The temperature of setting concrete should not be lower than 40 deg. F., and to ensure this concrete should be placed at a temperature of about 64 deg. F. During hard and persistent frost the temperature of all the materials when put in the mixer should be between 68 deg. F. and 104 deg. F., but should not exceed 122 deg. F. at which temperature the concrete becomes quick setting. Steel containers used for transporting heated mixtures should be lined with boards. Shuttering boards, reinforcement bars, and construction joints should be heated before placing further concrete. Insulation of shutters, air heating of concrete when sliding shutters are employed, and electric heating of concrete are suggested for very cold weather. In walls, concrete should be put in position in short layers rather than in long continuous lifts. Chemicals such as salt, soda, and calcium chloride should be employed only in exceptional circumstances. Calcium chloride should not be used in reinforced concrete or in concrete made with high-alumina cement.



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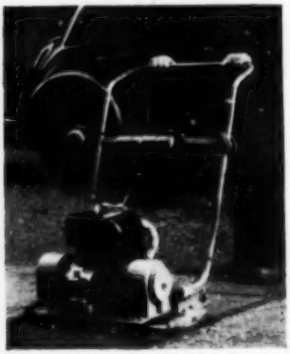
THE petrol-driven machine shown in the illustration is designed for compacting stiff concrete, asphalt, tar macadam, and other road surfaces, and is suitable for small areas, such as repairs, and for use in confined spaces; it can be used close up to walls and kerbs. The machine, known as a "Tampactor", is fitted with a 3-h.p.



air-cooled petrol engine, and for use on asphalt the exhaust gases are used to heat the tamping shoe. The tamping weights can be varied from a force of 400 lb. to 550 lb., and the frequency can also be varied. The machine is supplied by Messrs. E. P. Allam & Co., Ltd.

Change of Address.

THE address of Mr. J. Bak, consulting engineer, is now 24 Baker Street, London, W.1 (telephone: Welbeck 7091 and 2932).

Prestressed Concrete.

A BROCHURE entitled "Prestressed Concrete Manual," in which the Magnel-Blaton system is described and illustrated, is available from Stressed Concrete Design, Ltd., 54 South Side, London, S.W.4.

A Large Concrete Mixer.

A DRUM-TYPE concrete mixer with a mixed batch capacity of 6½ cu. yd. is in use in the construction of a new steel plant at Morrisville, Pa., U.S.A.

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(Contracts up to £5000. Inc. 10 per cent. profit.)

PORTLAND CEMENT CONCRETE, 1 : 2 : 4.—
Foundations, 2*s.* 3½*d.* per cu. ft. Columns, 3*s.* 1½*d.* per cu. ft. Beams, 2*s.* 10½*d.* per cu. ft. Floor slabs 4 in. thick, 8*s.* 3*d.* per sq. yd.; Do., 5 in., 10*s.* 4½*d.*; Do., 6 in., 11*s.* 10½*d.*; Do., 7 in., 13*s.* 11*d.* Walls 6 in. thick, 13*s.* 3½*d.* per sq. yd. Add for hoisting above ground level 3*s.* 6*d.* per cu. yd. Add for rapid-hardening Portland cement 2*s.* 6*d.* per cu. yd.

REINFORCEMENT.—Mild steel bars (B.S. 785), including cutting, bending, fixing, and wire (per cwt.)—¼ in. to ¾ in., 68*s.* 6*d.* ⅜ in. to ½ in., 63*s.* ⅝ in. to 2¾ in., 57*s.* 6*d.*

SHUTTERING AND SUPPORTS.—
Walls, 203*s.* 6*d.* per square.
Floors (average 10 ft. high), 189*s.* 6*d.* per square. In small quantities, 2*s.* 6*d.* per sq. ft.
Columns, average 18 in. by 18 in. (per sq. ft.), 2*s.* 10*d.*; in narrow widths, 3*s.* 7*d.*
Beam sides and soffits, average 9 in. by 12 in. (per sq. ft.), 2*s.* 9*d.*; in narrow widths, 3*s.* 3*d.*
Raking, cutting, and waste, 5*d.* per lin. ft.
Labour on splays, 2½*d.* per lin. ft.
Small fillets to form chamfers, 5*d.* per lin. ft.

Wages.

The rates of wages on which the above prices are based are: Carpenters and joiners, 3*s.* 6*d.* per hour (carpenters 2*d.* a day tool money); Labourers, 3*s.* 0½*d.*; Men on mixers and hoists, 3*s.* 2½*d.*; Bar-benders, 3*s.* 3*d.*

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a Day and a Night...

concrete sufficiently hard for almost any purpose

After 8 hours concrete made with 417 Cement is as strong as that made with ordinary Portland cement after 24 hours — strong enough, in fact, in a temperature of 60°–65°F., for the vertical shuttering of walls to be stripped. After 12 hours it is hard enough for concrete floors to carry foot traffic. And after 24 hours all-concrete roads and aerodrome runways can be open for traffic. 417 Cement can be used for plain and reinforced concrete. It is invaluable for new, urgent work and for repairs to services that must be reinstated without delay. Moreover, concrete made with 417 Cement is less liable to damage by frost. Please write for full details.

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